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ABSTRACT

This handbook was prepared to accompany a series of programed study guides for first-year algebra. It presents the rationale and development of the program; gives an itemized summary of the strategies and logistics involved in installing and operating the program as an individualized, self-paced, computer-managed course of instruction; and specifies the principles and procedures followed in creating the program. Three texts are cross-referenced to the material in this series: the core text, "Modern Algebra - Book I" by Dolciani, Berman, and Freilich; the enrichment text, "Algebra I" by Dodes and Greitzer; and the remedial text, "Comprehensive Ninth Year Mathematics" by Dressler. (Related documents are SE 015 855 - SE 015 870.) (DT)

ED 075200

PROGRAMMED MATH CONTINUUM

level one

ALGEBRA

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HANDBOOK

NEW YORK INSTITUTE OF TECHNOLOGY
OLD WESTBURY, NEW YORK

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SE 015 854

ED 075200

P R O G R A M M E D M A T H C O N T I N U U M

LEVEL ONE

A L G E B R A

H A N D B O O K

Prepared by
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P.M.C. Project Director

New York Institute of Technology
Old Westbury - New York

December 1969

PREFACE

This Handbook has been prepared to accompany the 18 Volume series

entitled

PROGRAMMED MATHEMATICS CONTINUUM

LEVEL I

IT HAS THE MULTIPLE FUNCTION OF PRESENTING:

THE RATIONALE AND DEVELOPMENT OF THE PROGRAM

- FOR EVALUATION

THE STRATEGIES AND LOGISTICS OF THE PROGRAM

- FOR INSTALLATION

THE PRINCIPLES AND PROCEDURES SUGGESTED

- FOR REPLICATION

It is one exhibit in the demonstration of a model

developed under the direction of

the U.S. Department of Health Education and Welfare

OE Project 8-0157

at the

New York Institute of Technology

Westbury, New York

TABLE OF CONTENTS

PREFACE		B
CHAPTER I		
	RATIONALE AND DEVELOPMENT ...FOR EVALUATION	1
	GENERAL BACKGROUND	3
	*SYLLABUS	8
CHAPTER II		
	STRATEGIES AND LOGISTICS ...FOR INSTALLATION	19
	ABSTRACT	24
	PROJECT COUNTERPARTS	34
	INFORMATION FLOW	36
	STUDENT PROGRESS	38
	STUDENT LEARNING ACTIVITIES	42
CHAPTER III		
	PRINCIPLES AND PROCEDURES ...FOR REPLICATION	45
	PRODUCTION CHRONOLOGY	47
	COURSE COMPONENTS	51
	LEARNING CATEGORIES	52
	QUESTION PLACEMENT	53
	QUESTION MODE	55
	PRINCIPLES OF CRITERION CHECK CREATION	57
	DISTRACTOR STRATEGY	59
	STUDY GUIDE CREATION	62
	TEST CREATION	66
	TEST EVALUATION	70
	MBO CROSS REFERENCE	74
	SCRAMBLED PAGINATION	77
	MULTIPLE BRANCH STRATEGY	83
*NOTE CONCEPT CATALOG		In separate booklet
DETAILED MBO LIST		

PROGRAMMED MATHEMATICS CONTINUUM

LEVEL I

HAND BOOK

CHAPTER I

THE RATIONALE AND DEVELOPMENT OF THE PROGRAM

- FOR EVALUATION

GENERAL BACKGROUND:

ORIGIN OF PROGRAM:

The New York Institute of Technology
submitted to the U.S. Commissioner of Education,
under the provisions of Public Law 531,
in the last quarter of the year 1967,
a basic and applied research proposal entitled:

A SYSTEM FOR INDIVIDUALIZING AND OPTIMIZING LEARNING
THROUGH COMPUTER MANAGEMENT OF THE LEARNING PROCESS

This proposal was accepted and resulted in the letting of

Contract Number: OEC -0-8-080157-3691 (010)
Office of Education, Bureau of Research
Project Number 8-0157
to
New York Institute of Technology

OBJECTIVES:

The Major Objective of the proposal was to organize, develop and refine a model computer-based system for the management of the educational process by means of a systems engineering technique.

CONDITIONS:

This management system would have to be operational and economically cost effective.

The system would be applied to different subject matter areas which would be developed simultaneously with the computer system into formats susceptible to management by the program.

The individual courses would be installed on the New York Institute of Technology campuses for experimental purposes.

The courses would also be installed on other school campuses as a demonstration of the ability of the program to handle varied management decision making situations.

OUTCOMES:

Immediate and constant feedback would result in course improvement. Individualized analysis of records would result in tailoring the course independently for each student in a self-paced mode.

Correlations generated by the computer would form a basis for individual and group counselling.

The principles, techniques, and findings of the project would be made available to the educational community.

PROCEDURES:

In order to accomplish the objectives of this proposal an "action research" program was prepared. It outlined:

First: the development of the management system.

Second: the testing and refinement of the management system through application to a specific environment in four subject matter areas.

Third: the repetition of the system in another context so as to demonstrate replicability.

Fourth: the training of appropriate members of the educational community who will be involved operationally in this effort.

Fifth: the dissemination of the findings of this study to the educational community at large.

PROJECT COMPONENTS:

Procedurally, the "action research" program may be considered to encompass several interrelated categories of activities.

MANAGEMENT SYSTEM:

An initial, and continuing category of activities covers the design and development of the computer-based management system itself, through which the assessment, revision, restructure, optimization and validation of the instructional system is to be accomplished.

MANAGEMENT SYSTEM (CONT.)

Since the system is self-generating and self-correcting, these activities involve empirical implementation and observation under actual living school conditions, and testing, modification and retesting in such a viable situation.

COURSE DEVELOPMENT:

Therefore, a concurrent category of activities addresses itself to the development of subject matter courses, with all appropriate support material, and their testing, revision, restructure and ultimate optimization and validation.

These activities are governed within the instructional management area of the system.

The method of attack, the step-by-step procedure whereby the courses are behaviorally defined, structured, refined and validated, evolves directly from the system design, and is controlled and directed by the computer-based management system.

COMPONENT INTER-RELATION:

These major categories of activities go on to a certain extent, concurrently, and one cannot proceed to culmination without the other.

The course development activity, particularly as it reaches the implementation and assessment stage, depends entirely upon the management system, with its immediate feedback and analysis.

COMPONENT INTER-RELATION: (CONT.)

The management system, conversely, requires the course development activity as its "test bed" upon which it bases its own growth and shape.

Final validation of both the course and the management system depends upon the experiences of the replication experiment.

COURSE SELECTION:

For the purposes of this program, New York Institute of Technology utilized as course areas; computer sciences, mathematics, physics, and electronic technology. These subject matter areas were chosen because:

They form entities which are relevant to the philosophies expressed in a recent appropriate Office of Education position paper as falling within an area of national need; the Institute possesses demonstrated expertise in these subjects.

They have relevance to secondary educational levels; prepared as is intended.

They can serve as remedial or preparatory materials for more advanced programs.

As end courses, themselves, they possess potential for wide use.

PROJECTED COMPLETION TIME:

The total program has been scheduled over a period of three years, in Phases I, II, and III, each with a consecutive period of approximately 12 months.

THE SYLLABUS:

SOURCE:

The syllabus has been written in accordance with the guidelines set up by the Curriculum Development committees of the High School Division of the Board of Education of the City of New York as exhibited in the publication: Mathematics, Ninth Year, 1966. This publication, in turn, reflects the influence of the thinking in the field of mathematics education by the New York State Board of Regents and the School Mathematics Study Group.

TIME SCHEDULE:

It is essentially a full year course in the first year of academic mathematics in preparation for the study of calculus. However, because of the interface with the computer and its consequent application to a self-paced individualization of the learning process the time schedule may vary considerably.

The material is divided into 18 major units, or Volumes; each covering a major unit of the material and corresponding to the amount of material that would be covered in a normal two-week period in a regular classroom situation.

Each Volume is subdivided into five parts, or Segments, and together with the reading and paralleled homework assignment comprise the material that would normally be covered in two class days. There are, therefore, a total of 90 segments which can be covered in the usual 180 day school year; or in a variety of other possible time spans.

REFERENCE TEXTS:

Three textbooks have been chosen from among the many because they are above average in meeting the purposes assigned to them.

The "Core Text"	Modern Algebra, Book I Dolciani, Berman, and Freilich Houghton Mifflin, 1965
The "Enrichment Text"	Algebra I Dodes and Greitzer Hayden Book Company, 1967
The "Remedial Text"	Comprehensive Ninth Year Mathematics Dressler Amsco School Publications, 1966

TEXT INDEPENDENCE:

The material in the Study Guides is not limited to the three referenced texts. With a minimum of analysis another set of texts could be readily cross-referenced to the material.

The PMC can be converted to a "stand alone" text-independent course by augmenting the supplementary notes prefacing each segment.

A set of problems could be prepared to replace the existing Remedial Prescriptions.

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HEW PMC

PROGRAMMED MATHEMATICS CONTINUUM

ALGEBRA LEVEL 1

COURSE OF STUDY

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
1	1	Introduction: general instructions				
	2	Representation of numbers on a line	1-1 (1-6)	1-3 (1-1)(1-2)	3-2 4-4 4-6	
	3	Comparison of number magnitude	1-2 1-3	1-4	2-5 3-1	
	4	Definition of set Kinds of sets	1-4 1-5 1-6	2-1 2-2 2-6 3-2 5-10	1-2 (1-3)	
	5	Investigation of subsets	1-7	2-3	1-2	
2	1	Mathematical punctuation marks Order of operations	1-8 1-9	1-6 1-5 (1-7)	2-7 4-10	
	2	Evaluation of algebraic expressions	2-1	3-6 to 3-9	4-12	
	3	Identification of factor, coefficient and exponent	2-2	3-5	4-1 4-2	
	4	Solution of algebraic open sentences	2-3	3-1 5-1	5-2	
	5	Translation: From symbols to words From words to symbols	2-4 2-5	3-3 1-8 3-3	5-5	

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PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
3	1	Solution of verbal problems with open sentences	2-6	3-4	5-5	
	2	Definition of axioms of equality	3-1	4-1	2-5	
	3	Definition of: Closure properties and Commutative, Associative properties	3-2 3-3	4-2 4-3 4-4	2-8 4-13	
	4	Definition of: Distributive property	3-4	4-5,4-6 4-7	4-13	
		Definition of: Addition and Subtraction Properties of equality	3-5	5-4	4-5	
	5	Definition of: Multiplication and Division Properties of equality	3-6	5-6	4-5	
4	1	Collection of similar terms	3-7	5-3 5-7 to 5-9 9-1 to 9-3	5-3	
	2	Solution of: Linear equations having the variable in both members	3-8	9-4	5-3	
	3	Definition of Directed numbers, comparison of size of unequal numbers	4-1 4-2	6-1 6-2 6-3	3-3 3-3	
	4	Addition on Number Line	4-3	6-6	3-4	
	5	Definition of: Opposite of directed number	4-4	6-4	3-4	
		Absolute value	4-5	6-5	3-7	

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PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
5	1	Addition of directed numbers	4-6	6-7	3-6 , 3-7	
		Subtraction of directed numbers	4-7	6-9	3-5 , 3-8	
	2	Multiplication of directed numbers	4-8	6-8	3-9 , 3-10	
	3	Division of directed numbers	4-9	6-10 (6-11)	2-6 , 4-3	
	4	Transformation of equations	5-1	9-5	5-2 , 5-3	
	5	Definition of The properties of inequality	5-2	9-8 9-9	5-4	
6	1	Plan for solving Verbal Problems	5-4	5-2 , 5-5	5-5 , 5-6	
	2	Solution of problems on consecutive integers	5-5	10-1 10-2	5-7	
		Solution of problems about angles	5-6	20-1 20-2	11-2	
	3	Solution of uniform motion problems	5-7	10-3	7-4 , 7-5	
	4	Solution of mixture problems	5-8	10-6	7-3	
	5	Addition of polynomials	6-1	(7-1) 8-1		
		Subtraction of polynomials	6-2	(7-2) 8-2		

PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

			(CORE)	(REMEDIAL)	(ENRICHMENT)	OTHER
VOL.	SEGMENT	DESCRIPTION	DOLCIANI	DRESSLER	DODES	TEXT
7	1	Determination of the multiplication of powers of a variable	6-3	7-3 7-4	4-2	
		Power of a product	6-4	7-4 11-3	4-2	
	2	Multiplication of polynomial by monomial	6-5	8-3 8-4	8-4	
	3	Multiplication of polynomial by polynomial	6-6	8-5	8-4	
	4	Solution of area problems	6-7	10-11	11-4	
	5	Division of powers of a variable	6-9	7-5 (7-6)	4-3	
8	1	Division of polynomial by monomial	6-11	8-6	8-5	
	2	Division of polynomial by polynomial	6-12	8-7	8-5	
	3	Separation of numbers into factors	7-1	11-1		
		Identification of common factors	7-2	11-2	8-6	
	4	Multiplication of the sum and difference of 2 numbers	7-3	11-4	8-4	
		Factorization of the difference	7-4	11-5	8-6	
	5	Multiplication of a binomial by itself	7-5	11-6	8-4	

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PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
9	1	Factorization of a trinomial square	7-6	11-7	8-7	
	2	Multiplication of binomials at sight	7-7	11-6	8-8	
	3	Factorization of the product of the sum and difference of two terms	7-8 7-9	11-7	8-8	
	4	Factorization of quadratic trinomials	7-10	11-7	8-8	
	5	Combination of types of factoring	7-11	11-8	8-8	
10	1	Solution of equations having factors whose product is zero	7-12	19-2	8-1	
	2	Solution of polynomial equations by factoring	7-13	19-1 19-2	8-7,8-9	
	3	Use of factoring in problem solving	7-14	19-11	8-7,8-9	
	4	Investigation of algebraic fractions	8-1	12-1	4-6	
		Reduction of fractions	8-2	12-2	4-7,8-6	
	5	Multiplication of fractions	8-5	12-3	4-8	
		Division of fractions	8-6	12-4	4-9	

PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
11	1	Multiplication and division of fractions involving factoring	8-7	12-4	4-10,8-6 8-9	
	2	Combination of fractions with equal denominators	8-8	12-5	4-11	
	3	Combination of fractions with unequal denominators	8-9	12-6	4-11 8-6,8-9	
	4	Investigation of mixed expressions	8-10	12-7	4-6, 4-12	
		Investigation of complex fractions	8-11*			
	5	Solution of open sentences with fraction coefficients	8-12	13-1 13-2 13-3	5-3	
12	1	Solution of investment problems	8-13	10-8	7-2	
	2	Solution of percent mixture problems	8-14	10-7		
	3	Solution of: fractional equations	8-15	13-4	5-3	
	4	Solution of work problems	8-16	13-9	7-7	
	5	Solution of motion problems	8-17	13-8	7-4,7-5	

* Optional topic for enrichment

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HEW PMC

PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
13	1	Solution of open sentences in two variables	9-1	15-3		
	2	Introduction to coordinates of a point in a plane	9-2	15-1 15-2	6-2	
		Determination of the graph of a linear equation	9-3	15-4 15-5 15-6	6-4,6-5 6-6	
	3	Definition of the slope of a line	9-4*	15-7	6-4	
		Transformation to the slope intercept form of an equation	9-5*	15-8 15-9	6-5	
	4	Construction of the graph of an inequality in two variables	9-7	15-12	6-12	
	5	Construction of the graphic solution of a system of simultaneous linear equations	10-1	16-1	6-8	
14	1	Solution of simultaneous linear equations by addition, subtraction and multiplication	10-2 10-4	16-2 16-2	6-9 6-9,6-1	
	2	Solution of simultaneous linear equations by the substitution method	10-5	16-3	6-9	
	3	Construction of the graphs of pairs of inequalities	10-6	16-5	6-12	
	4	Graphic solution of verbal problems with two variables	10-3,10-4	16-4	6-11	
	5	Determination of the equation of a line	9-6**	15-10	6-6	

* Optional topic for enrichment
** Special treatment needed-text will not be followed

PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

			(CORE)	(REMEDIAL)	(ENRICHMENT)	OTHER
VOL.	SEGMENT	DESCRIPTION	DOLCIANI	DRESSLER	DODES	TEXT
15	1	Solution of digit problems	10-7	16-4		
	2	Solution of motion problems	10-8	16-4	7-1	
	3	Solution of age problems	10-9	16-4	7-1	
		Solution of problems involving fractions	10-10	13-6		
	4	Investigation of the nature of rational numbers	11-1	18-1	4-6	
		Decimal form of rational numbers	11-2	18-1	8-3	
	5	Determination of the roots of numbers	11-3	18-4 18-5	9-4	
		Investigation of the properties of irrational numbers	11-4	18-2 to 18-9	8-2 8-3	
16	1	Geometric interpretation of square roots Pythagorean theorem	11-5	19-7 19-8	12-1	
	2	Simplication of radicals involving multiplication and division	11-6	18-10 to 18-12, 18-14 18-15	9-4,9-5 9-6	
	3	Addition and subtraction of radicals	11-7	18-13	9-6	
	4	Multiplication of binomial radicals	11-8*	18-14 18-16	9-4 9-5	
		Solution of radical equations	11-9*	18-17	9-7	
	5	Distinction between Relations and	12-1	22-1	6-1	
		Functions	12-2	22-3	6-3	
		Solution of problems involving direct variations and proportion	12-3	17-3 17-4 17-5	10-2	

* Optional topic for enrichment

N.IT

HEW PMC

PROGRAMMED MATHEMATICS CONTINUUM
ALGEBRA LEVEL 1
COURSE OF STUDY
(cont'd.)

VOL.	SEGMENT	DESCRIPTION	(CORE) DOLCIANI	(REMEDIAL) DRESSLER	(ENRICHMENT) DODES	OTHER TEXT
17	1	Solution of problems involving Inverse variations	12-4	17-3, 17-4 17-6	10-3	
		Joint and combined variation	12-5*		10-2 10-4	
	2	Solution of quadratic equations by the square root property	13-1	19-3	8-11	
	3	Solution of quadratic equations by completing square	13-3	19-4 19-5	8-11	
	4	Continuation of solution of quadratic equations by completing square	13-3	19-4 19-5	9-11	
	5	Solution of quadratic equations by the quadratic formula	13-4*	19-6	8-11	
18	1	Investigation of Geometric assumptions	14-1		11-1	
		Definition of Rays and angles	14-2	20-1 20-2	11-2	
	2	Solution of problems involving similar triangles	14-3	20-3		
	3	Solution of problems involving ratios	8-3	17-1 17-2	10-1	
	4	Application of tangent function to problems	14-4	21-1	12-2 12-3	
	5	Application of sine function and cosine function to problems	14-5	21-2 21-3	12-4	

* Optional topic for enrichment

PROGRAMMED MATHEMATICS CONTINUUM

LEVEL I

HAND BOOK

CHAPTER II

STRATEGIES AND LOGISTICS OF PROGRAM

- FOR INSTALLATION

STRATEGIES FOR INSTALLATION

OF

PROGRAMMED MATHEMATICS CONTINUUM

LEVEL 1

AS

SPECIAL EDUCATION M 3012

ABSTRACT: This is an itemized summary of the strategies and logistics involved in the installation and operation of the PMC as an individualized, self-paced, computer managed course of instruction with provision for course optimization, open-ended scheduling and a consequent cost effective motivation for concentrated individual effort.

NOTE: This outline is directed towards the installation of the PMC as Special Education Course 3012 on the NEW YORK INSTITUTE OF TECHNOLOGY CAMPUS.

With appropriate modifications contingent upon local circumstances similar instructions can be devised for installation in other school programs.

1. CURRICULUM:

1.1 DATA:

1.11 The PMC comprises the material outlined in the New York State Syllabus for ELEMENTARY ALGEBRA NINTH YEAR (level 1) and is in conformity with recommendations for curriculum content as promulgated by the Standing Committee on Mathematics, NYC and the School Mathematics Study Group, (SMSG) .

1.12 The NYIT Catalog stated that Math 3012 is an intensive course involving the algebraic concepts identical with those of the PMC (level 1) .

1.2 CONCLUSION:

1.21 The PMC is suitable for Math 3012 .

2. COMPUTER ARTICULATION:

2.1 DATA:

2.11 Each concept has been cast into the MEASURABLE BEHAVIORAL OBJECTIVE format.

2.12 Each MBO is coded by Volume, Segment, Terminal Objective or Enabling Objective.

2.13 Each question and each answer in every component of the course is assigned an MBO code.

2.2 CONCLUSION:

2.21 The student's progress through the PMC can be constantly monitored by the AIMS/VICAR program.

2.22 Reference is made to the full report on VICAR I and VICAR II as well as the AIMS report.

3 COURSE COMPONENTS:

3.1 PRE-TEST:

3.11 One test per volume.

3.12 Test administered individually, in class, when student has met requirements of previous volume.

3.13 Ten questions on 2 or 3 mimeographed sheets.

3.14 Multiple-choice format, with one answer and four distractors;

3.15 Answers recorded on Punch Card with Stylus and Port-A-Punch

3.16 Scored by computer;

3.17 Statistics for individual and for group compiled;

3.18 Provision possible for exempting student from following Volume if score is above a certain level.

3.2 STUDY GUIDE:

3.21 Eighteen Volumes for entire course; scrambled and programmed;

3.22 Five Segments per Volume; each Segment comprises approximately Twenty questions;

3.23 Questions are in multiple choice format, with one answer and three distractors;

3.24 Student progresses from question to answer choice by recording choice on either Punch Card and Program Control device, or on Mark Sense Sheet which records the choice and reveals the page to which the student must turn.

3.25 A separate answer matrix is required for each Segment.

3.26 Correct answers are sometimes re-enforced by a complete demonstration of the solution and the direction to proceed to the following question.

3.27 Readings in the basic text are prescribed and must be completed before beginning each Segment.

3.28 Homework Assignments are prescribed.

3.3 WORK OUTSIDE OF CLASS:

3.31 READING ASSIGNMENT:

3.311 The Study Guide specifies a certain section of the core text, (MODERN ALGEBRA, Dolciani) that should be read and studied by the student before he begins each Segment. A complete listing is given at the beginning of the Volume and individual listings are given at the beginning of each Segment.

3.312 Each Segment is designed to cover a two-day lesson including the Reading and Study Guide.

3.32 HOMEWORK ASSIGNMENT:

3.321 The complete assignment for the entire Volume is given on one page in the Study Guide.

3.322 Each Segment makes reference at its completion to the parts of the Homework that the student should then be able to do.

3.323 The entire Homework assignment must be completed before the student is allowed to take the Post-Test.

3.324 The Homework Assignment is marked by the instructor, with the marks recorded on a Punch Card.

3.325 A complete description of the Homework marking principles and the resulting printouts is found in the VICAR I report.

3.33 POST-TEST PRESCRIPTION:

3.331 The Computer Printout of the results of the Post-Test includes a prescription of extra problems that relate to the error made.

3.332 The problems are found in the Remedial Text: Comprehensive Ninth Year Mathematics; Dressler.

3.333 The Prescription must be completed before the student can begin the cycle for the following Volume.

3.34 TUTORIAL SESSION:

3.341 In some cases the Computer Printout will indicate that the student must report to the instructor for a tutorial session, because of a difficulty detected.

3.342 The Computer Printout will be distributed by the instructor in class. At that time an appointment can be arranged.

3.343 This session can be conducted in class while the others are working individually in their Study Guides:

3.344 The session could be arranged at a mutually convenient time outside of the class hour.

3.4 POST TEST:

3.41 One Post Test per Volume;

3.42 Form and Content are equivalent to the Pre-Test;

3.43 Incorrect answers are accompanied by a Prescription of additional problems in the Review Text.

3.44 The prescription must be completed before the student can advance;

3.45 Tutorial sessions can also be prescribed.

3.46 Under the AIMS/VICAR program statistics of individual and group performance are compiled and printed.

3.5 MID-TERM EXAMINATION:

3.51 A 20 question multiple choice format

3.52 Based on the Terminal Objectives of Volumes 1-9

3.53 Each question will have 5 forms, all equivalent.

3.54 A large variety of individual tests will be possible by choosing the alternate forms at random.

3.541 If the CAI program is ready, then the student can take the test individually when he is ready, with certain time periods with the computer randomly selecting the permutations of question variations as well as scoring the performance.

3.542 If the program is not ready, as a back-up system, the 100 question test can be presented in mimeo form together with directions to choose a certain random selection of predetermined permutations.

3.6 FINAL EXAMINATION:

3.61 Similar to the Midterm as discussed above;

3.62 It will cover the TOs from Volumes 10 to 18 , principally.

4. TIME CONSTRAINTS:

4.1 DATA:

4.11 The PMC is designed as a year course for secondary schools; i.e. a maximum of 180 days, 40 minutes per session (120 hours)

4.12 A realistic assessment of actual instruction hours reduces the time to approximately 100 hours.

4.13 Trial runs by good/average students, making few errors, indicate that a Volume can be read in 2 to 3 hours; this is exclusive of the time needed for reading and studying the core text.

4.14 The Pre-Test and the Post-Test each take $\frac{1}{2}$ hour.

4.15 The Textbook reading Assignment, Studying, Homework Assignment, Post-Test Remedial Prescriptions, and Tutorial Sessions are considered time spent outside of the regular class schedule.

4.16 The minimum time projection for the completion of the 18 Volume Course, for a good student would be from 54 hours to 72 hours. Additional time (on the items in 4.15) spent outside of class time would range from $1\frac{1}{2}$ to 2 hours more per Volume.

4.17 Math 3012 is scheduled to meet for 14 weeks at 4 hours per week for a total of 56 hours.

4.18 A Math 3012 student would have to complete a Volume and all of the outside work in 3 class hours beginning the following Volume in the 4th hour.

4.2 CONCLUSION:

4.21 The PMC course can be installed as the Math 3012 course only if the Math 3012 can be considered " open ended, " that is, it can extend into the second semester.

4.22 The Program will have to be individually self-paced. This will automatically answer the question as to how long it takes a student to go through the course with the out-of-class work and the computer management.

5. PHYSICAL FACILITIES:

5.1 ROOM REQUIREMENTS:

5.11 If the Punch Card Program Control is to be used the classes must be held in the Automated Lab where the devices are installed; Additional sections at different times are needed if the registration exceeds the room capacity (and the number of Controls 34)

5.12 If the Mark Sense sheets are used there is no need for a special room. However, the room should be located near the Automated Lab (which will be used as a supervised individual study lab for the students who wish to do extra work on their own.)

5.13 The section can be scheduled at any time.

5.14 Storage facilities in the Automated Lab will be needed for:

Volumes

Software

Records

6. PERSONNEL REQUIREMENTS:

6.1 INSTRUCTION:

6.11 An instructor must be assigned to each regular class session for supervision of the operation of the course.

6.12 Distribution of printouts with attention given to results.

6.13 Individual instruction when requested.

6.14 Marking of Homework Assignments (possible in the presence of the student for individual attention.)

6.15 Administration of individual tests; maintenance of security.

6.16 Counselling and recommending tutoring.

6.2 PROCTORING:

6.21 A secretary must be on duty in the Automated Lab for the issuing and collecting of the Volumes and other software needed by the students who are working on their own. Records must be kept of the students progress and the materials used. Security must be maintained.

6.3 COMPUTER OPERATION:

6.31 A member of the computer operations staff must be assigned to process the input received from the PMC.

6.32 All input must be processed on an overnight basis; (i.e. input received on one day must be processed and the output ready for pick-up the following morning before class.)

6.4 COORDINATION:

6.41 A Mathematics Coordinator is needed to supervise the complete operation of the PMC in Math 3012:

6.411 Registration figures

6.412 Teaching Schedules

6.413 Book Supplies (Cooperation with Bookstore)

6.414 PMC material distribution; directions to instructors and secretary for material accountability and security.

6.415 Interface operations with Computer:

delivery of input to computer center

inspection of operation of computer program

pick-up of output from computer

delivery of all output to Program Director

6.416 Maintain a flexible tutoring schedule dependent upon student needs and to do the tutoring.

6.417 Make periodic reports of the entire operation to the Program Director and to the Director of Special Education.

7. STUDENT PROGRESS:

7.1 CONTROL SHEET:

7.11 A single control sheet (attached) has been created to monitor the student's progress throught the PMC.

7.12 Each item of software will be numbered for reference.

7.13 When a software item is issued to a student, either by the instructor or by the secretary (on the same form) the software register number must be entered.

7.14 When the item is returned (same day) the date is entered.

7.2 SEQUENCE OF ACTIVITIES:

7.21 PRE-TEST:

7.211 Taken in class under supervision of instructor whenever student is ready;

7.212 Answers recorded on Punch Card/Port-A-Punch

7.213 Card collected and delivered to Computer;

7.214 Printout delivered to Instructor/Student at beginning of next session;

7.215 Printout indicates whether student is exempt from remainder of Volume.

7.22 VOLUME/SEGMENT:

7.221 Volume is issued to student together with Answer Matrix for Segment. (If Program Control Device used, student also requires Punch Card.)

7.222 Numbers of software are entered on Control Sheet

7.223 If Mark Sense response forms are used, the Volume/Segment material can be issued either in class or the Automated Lab.

7.224 When completed, the material is returned to instructor (or secretary) the date (same day) is recorded on the Control Sheet.

7.225 The Response Sheet (or Punch Card) is delivered to the Computer.

7.23 READING ASSIGNMENT:

7.231 The Reading is done outside of class prior to the work on the Segment.

7.24 HOMEWORK ASSIGNMENT:

7.241 The Homework is done outside of class simultaneously as the student progresses through the Volume.

7.242 The Complete Homework Assignment must be handed in to the Instructor upon completion of the Volume; it is pre-requisite for taking the Volume Post-Test.

7.243 Entry of the completion is made on the Control Sheet.

7.244 The Homework is marked by the Instructor on a Punch Card

7.245 A special feature is to have the student present while the homework is being marked; it gives an opportunity for the instructor to give personal attention to the student.

7.25 POST TEST:

7.251 Taken in class under supervision of instructor, when student is ready;

7.252 Answers on Punch Card/Port-A-Punch

7.253 Cards collected and delivered to computer;

7.254 Entry made on Control Sheet of issuance and completion;

7.255 Printout delivered to instructor and student.

7.26 REMEDIAL PRESCRIPTION:

7.261 Post Test Printout includes a Remedial Prescription;

7.262 Prescription must be completed outside of class and submitted to instructor;

7.263 Prescription might include a recommendation to report for a tutoring session either with class instructor or with Math Coordinator;

7.27 TUTORIAL SESSION:

7.271 Assigned by means of computer printout upon analysis of error count.

7.272 Can be assigned, with agreement of student, either during available class time (with instructor available) or at other time with Math Coordinator.

7.273 If a tutorial session has been assigned, it must be held and attended satisfactorily before student is permitted to advance in the program.

7.274 Entry of assignment and completion is made on Control Sheet.

8. MOTIVATION

8.1 TIME VARIATION: INDIVIDUALIZATION:

8.11 The quick student can progress through the course making few errors and covering the material at his own learning pace;

8.2 REMEDIATION:

8.21 The student having difficulty is helped:

8.211 Remedial pages in the Study Guide;

8.212 Personal interview while Homework is being marked;

8.213 Remedial prescriptions in Post Test printout with recourse to a different text for remedial instruction

8.214 Tutorial session with class instructor or with Mathematics Coordinator for Personalized attention.

PMC STUDENT PROGRESS CONTROL SHEET
SOFTWARE DISIRIBUTION

STUDENT : _____

I.D NO : _____

Enter software register number when issued
Enter date (e.g. 9/15) when completed

SECTION : _____

		VOL 1	VOL 2	VOL 3	VOL 4	VOL 5	VOL 6	VOL 7	VOL 8	VOL 9
PRE-TEST	ISSUED:									
	COMPLETED:									
	EXEMPT									
VOL/SEG 1	ISSUED:									
	RE-ISSUED:									
	COMPLETED:									
VOL/SEG 2	ISSUED:									
	RE-ISSUED:									
	COMPLETED:									
VOL/SEG 3	ISSUED:									
	RE-ISSUED:									
	COMPLETED:									
VOL/SEG 4	ISSUED:									
	RE-ISSUED:									
	COMPLETED:									
VOL/SEG 5	ISSUED:									
	RE-ISSUED:									
	COMPLETED:									
HOMEWORK	SUBMITTED:									
	GRADED:									
POST-TEST	ISSUED:									
	COMPLETED:									
PRINTOUT:	ISSUED:									
PRESCRIPTION	COMPLETED:									
TUTORIAL SESSION	ASSIGNED:									
	APPOINTMENT:									

PROJECT COUNTERPARTS

1. The schematic diagram on the facing page is designed to show the function and interrelation of the several software and hardware items that comprise the information flow resulting in the various printouts.

2. There is provision for A/V support when it is incorporated into the program.

3. INPUT INTERFACE:

   3.1 PUNCH CARD:

   The original PMC employed the four specially designed Punch Cards. For the Study Guide, the Punch Card required an ANSWER MATRIX and the PROGRAM CONTROL LIGHT PANEL to negotiate the Scrambled Pagination and at the same time to record suitable input for computer analysis.

   3.2 LATENT-IMAGE MARK SENSE SHEETS:

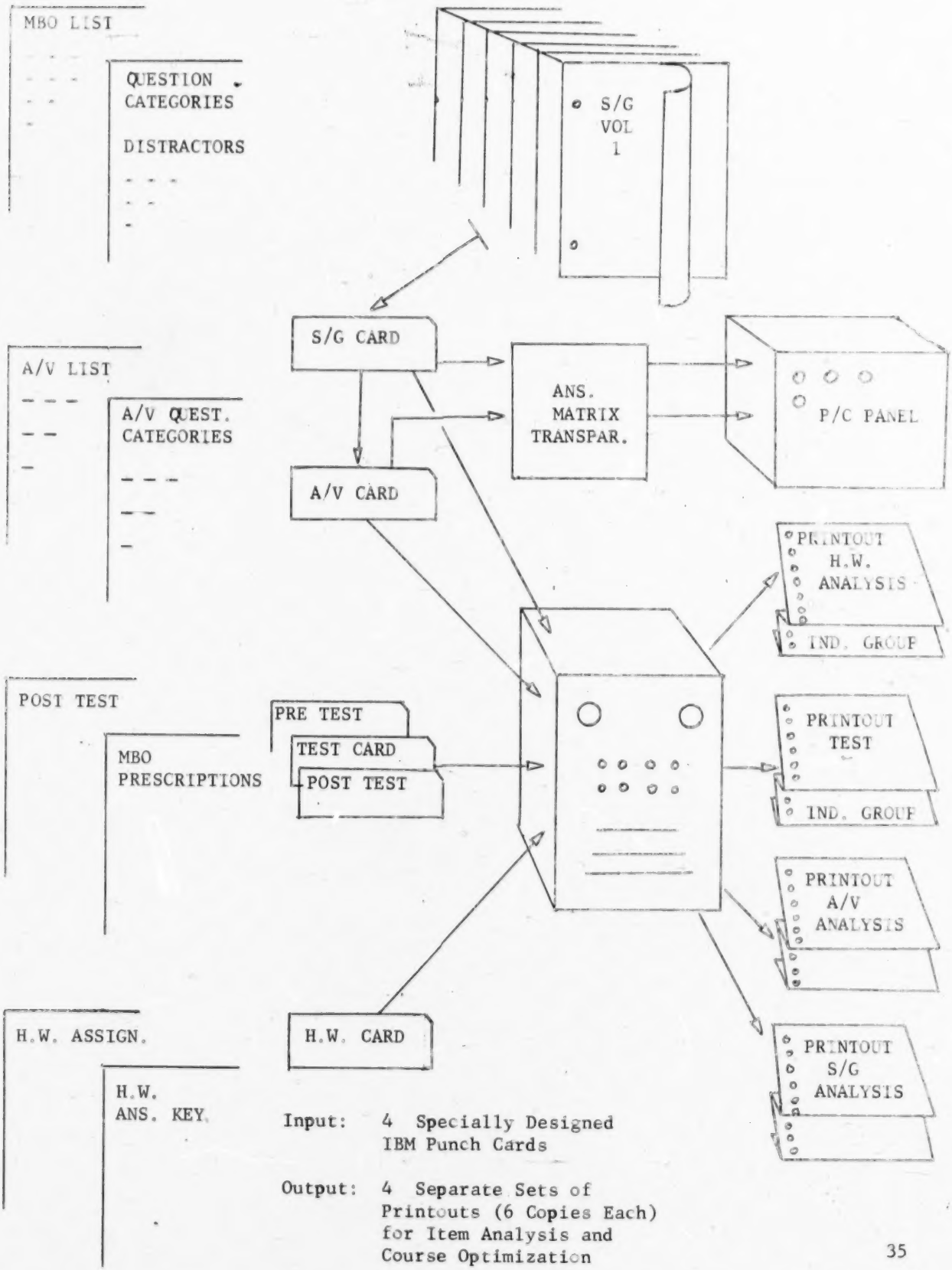
   Subsequent to the beginning of the PMC Study Guide production, a latent image (invisible ink process) sheet was devised to serve the same purpose as the Punch Card.

   It proved to be cost effective because it eliminated the need for a separate answer matrix, the PROGRAM CONTROL LIGHT PANEL, and the more expensive Punch Card.

   The one sheet, with the matrix imprinted invisibly, upon the application of a special pen, revealed the page number of the Study Guide at the same time that it recorded the answer choice for direct computer input and analysis.

   3.3 For consistency, all references to the Response Device continued to use the words "PUNCH CARD," "ANSWER MATRIX," etc. although either method of response could be employed.

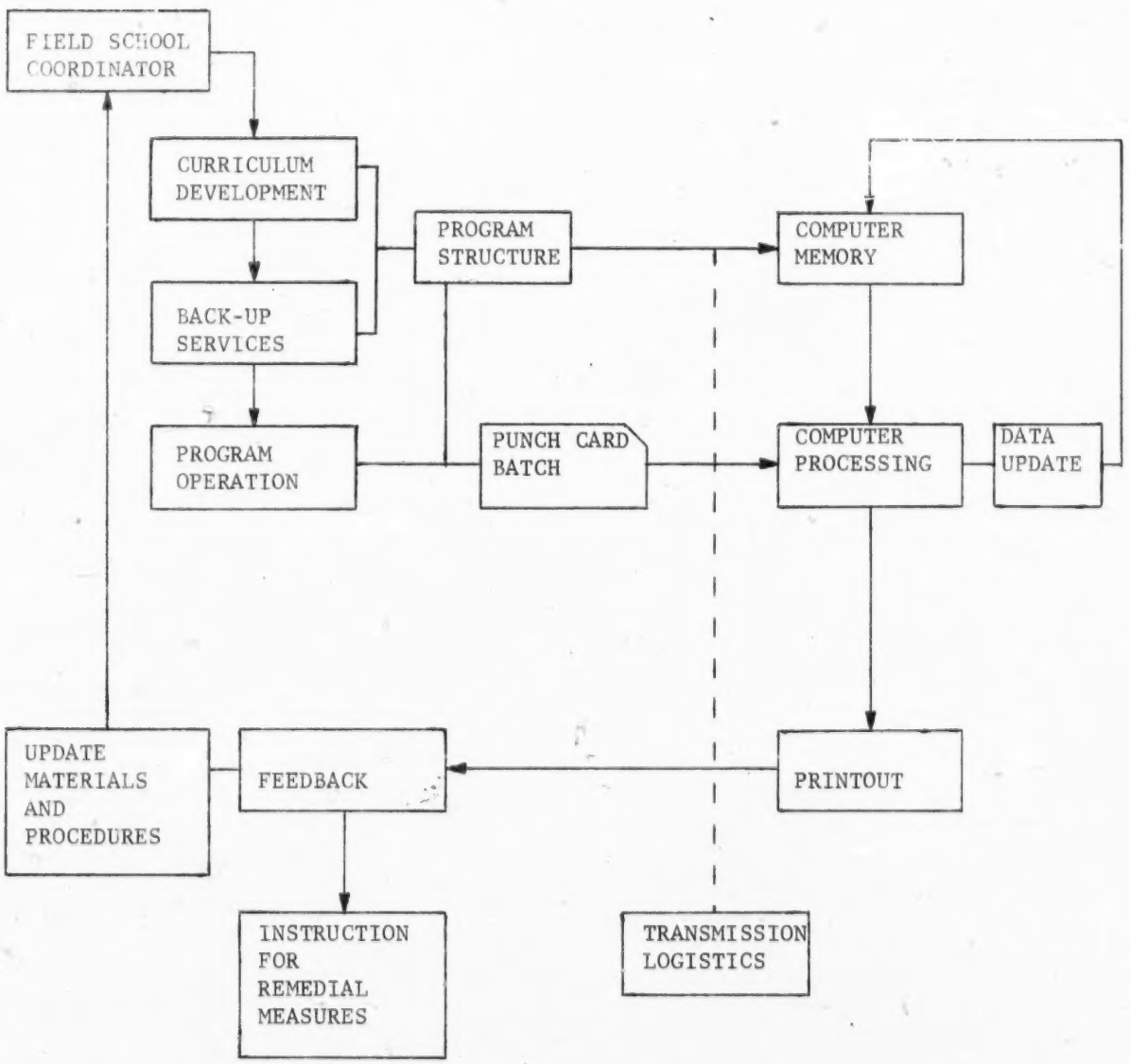
PROJECT COUNTERPART FLOW-CHART



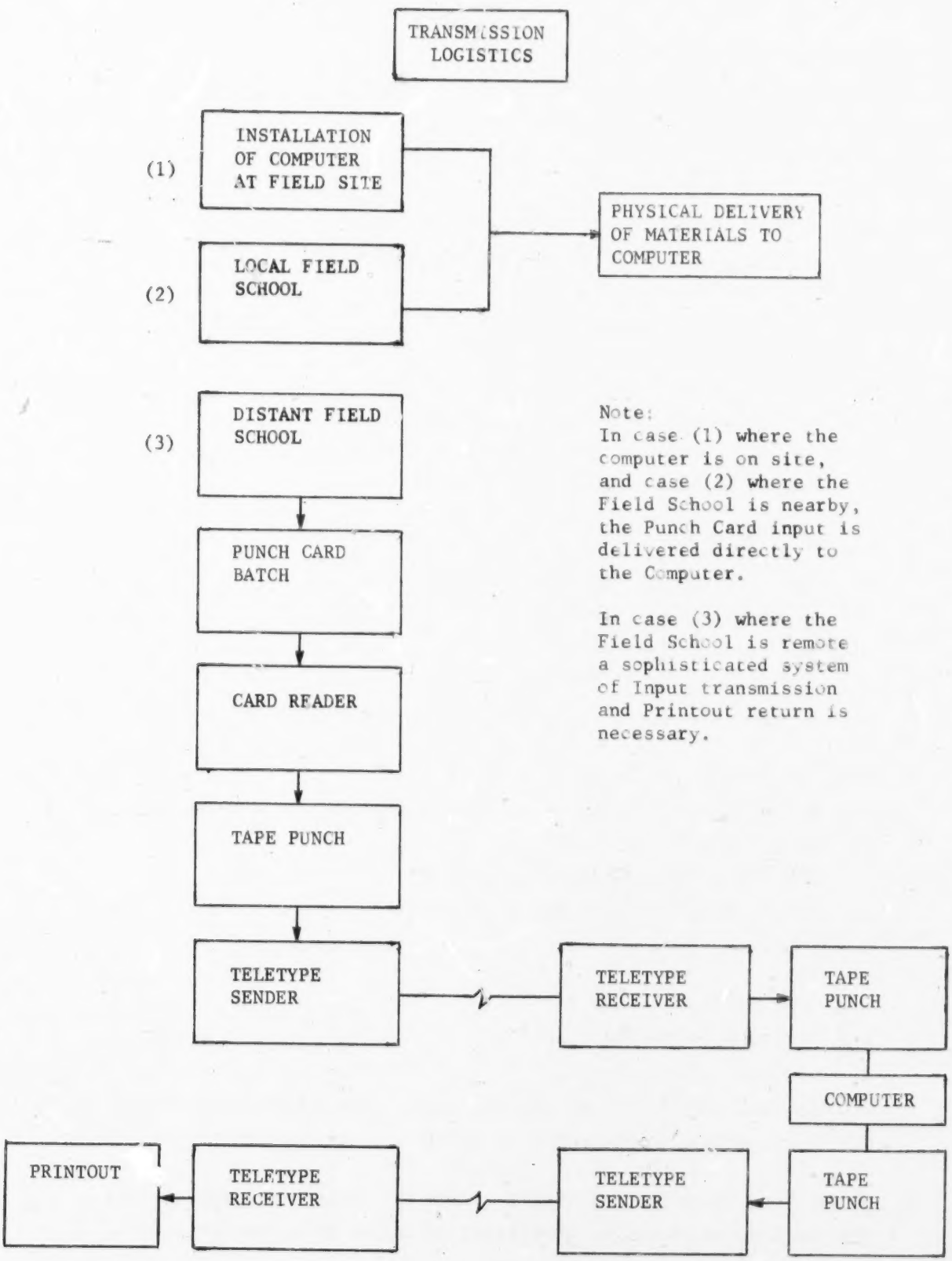
Input: 4 Specially Designed IBM Punch Cards

Output: 4 Separate Sets of Printouts (6 Copies Each) for Item Analysis and Course Optimization

INFORMATION FLOW CHART



INFORMATION FLOW CHART



Note:
In case (1) where the computer is on site, and case (2) where the Field School is nearby, the Punch Card input is delivered directly to the Computer.

In case (3) where the Field School is remote a sophisticated system of Input transmission and Printout return is necessary.

STUDENT PROGRESS THROUGH VOLUME - PLAN A

1. STUDY GUIDE: (For each segment)
   - 1.1 Completes READING ASSIGNMENT in CORE TEXT and in ENRICHMENT TEXT
   - 1.2 Reads SUPPLEMENTARY NOTE
   - 1.3 Reads QUESTION
   - 1.4 Chooses ANSWER
   - 1.5 Receives REMEDIAL INSTRUCTION (if DISTRACTOR chosen)
   - 1.6 Receives REINFORCEMENT (if CORRECT ANSWER)
   - 1.7 Response device submitted
   - 1.8 PUNCH CARD or (latent image sheet) analyzed by computer

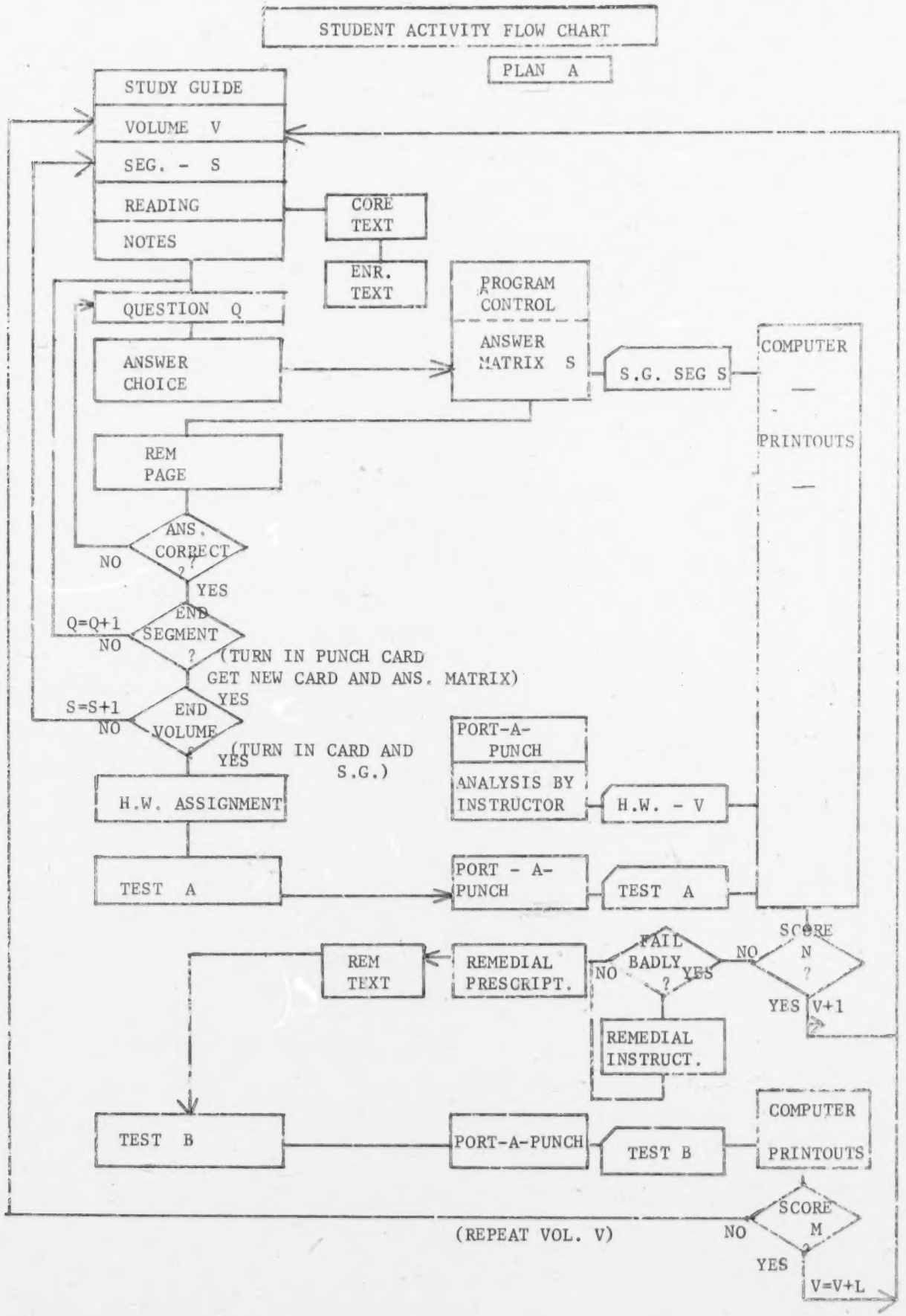
2. HOMEWORK ASSIGNMENT:
   - 2.1 Partially done at conclusion of each SEGMENT
   - 2.2 Marked by instructor or RESPONSE DEVICE when completed
   - 2.3 Analyzed by computer

3. TEST A:
   - 3.1 Test on M.B.O.'s of entire volume
   - 3.2 RESPONSE DEVICE submitted
   - 3.3 Analyzed by computer
   - 3.4 REMEDIAL PRESCRIPTIONS provided by computer
   - 3.5 Students above cut-off point move to next VOLUME

4. REMEDIAL INSTRUCTION:
   - 4.1 Student scoring below cut-off point reports for individual or group instruction (live)
   - 4.2 Available support materials arranged
   - 4.3 G.M.I. SESSIONS scheduled by computer

5. TEST B:
   - 5.1 Test similar to TEST A
   - 5.2 Response device submitted
   - 5.3 Analyzed by computer
   - 5.4 Evidence of additional learning made with comparison to TEST A scores
   - 5.5 Score above cut-off point allows student to proceed to next VOLUME

6. Score below cut-off point refers student to counseling, additional instruction; and possible repetition of volume or course adjustment


STUDENT ACTIVITY FLOW CHART
PLAN A
STUDY GUIDE
VOLUME V
SEG. - S
READING
NOTES
CORE TEXT
ENR. TEXT
PROGRAM CONTROL
ANSWER MATRIX S
S.G. SEG S
COMPUTER
PRINTOUTS
QUESTION Q
ANSWER CHOICE
REM PAGE
ANS. CORRECT ?
NO
YES
Q=Q+1
END SEGMENT ?
NO
(TURN IN PUNCH CARD GET NEW CARD AND ANS. MATRIX)
YES
S=S+1
END VOLUME ?
NO
YES
(TURN IN CARD AND S.G.)
PORT-A-PUNCH
ANALYSIS BY INSTRUCTOR
H.W. - V
H.W. ASSIGNMENT
TEST A
PORT - A-PUNCH
TEST A
SCORE N ?
NO
YES
V+1
FAIL BADLY ?
NO
YES
REMEDIAL PRESCRIPT.
REM TEXT
REMEDIAL INSTRUCT.
TEST B
PORT-A-PUNCH
TEST B
COMPUTER PRINTOUTS
SCORE M ?
NO
YES
V=V+L
(REPEAT VOL. V)

STUDENT PROGRESS THROUGH VOLUME - PLAN B

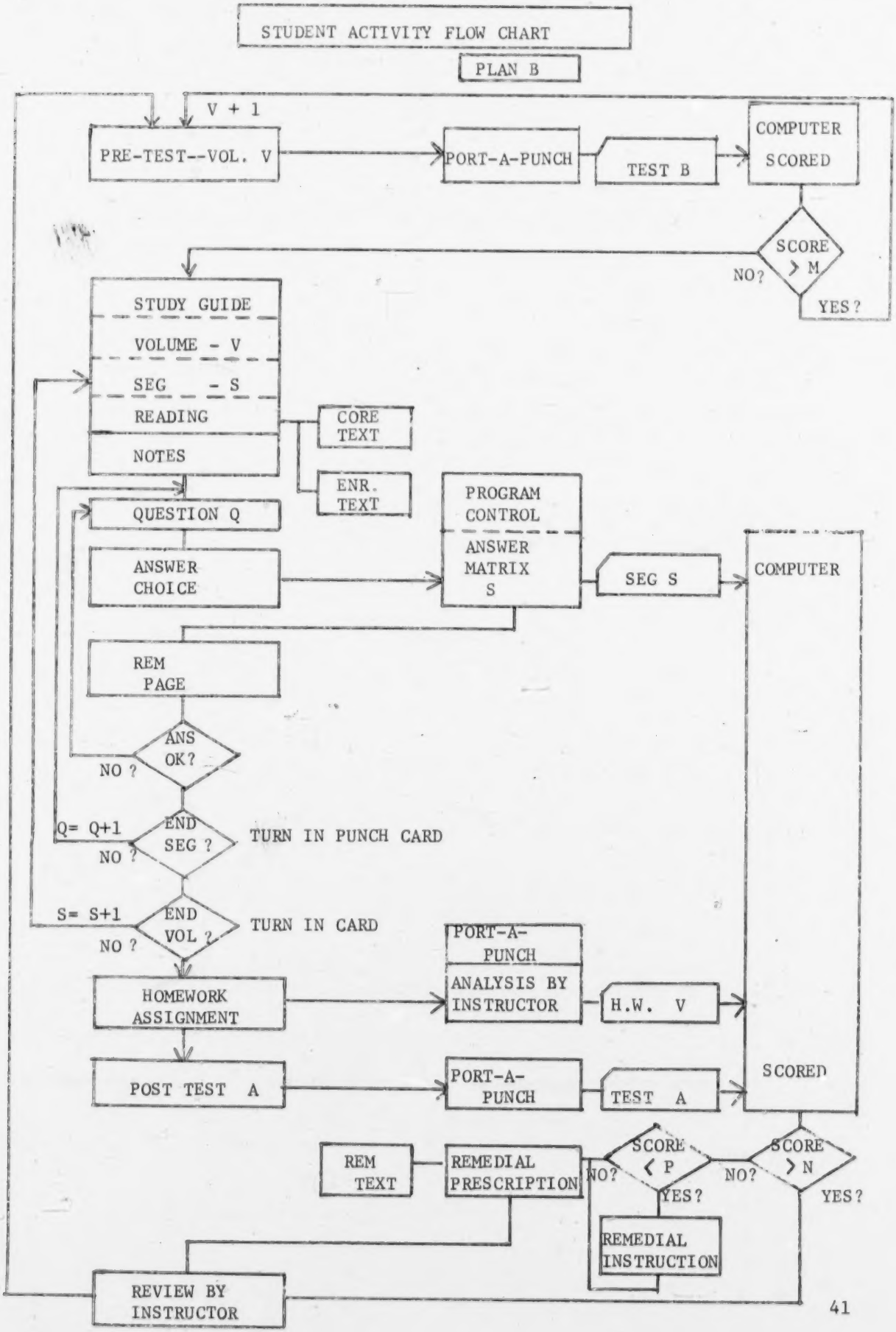
1. TEST B: ("BEFORE" TEST)
   - 1.1 Test on MBO's of entire Volume
   - 1.2 Response device submitted
   - 1.3 Analyzed by computer
   - 1.4 Score above cut-off point allows student to proceed to next VOLUME
   - 1.5 Score below cut-off point directs student to begin Volume

2. STUDY GUIDE: (For each segment)
   - 2.1 Completes READING ASSIGNMENT in CORE TEXT and in ENRICHMENT TEXT
   - 2.2 Reads SUPPLEMENTARY NOTE
   - 2.3 Reads QUESTION
   - 2.4 Chooses ANSWER
   - 2.5 Receives REMEDIAL INSTRUCTION (if DISTRACTOR chosen)
   - 2.6 Receives REINFORCEMENT (if CORRECT ANSWER)
   - 2.7 Response device submitted
   - 2.8 PUNCH CARD or (latent image sheet) analyzed by computer

3. HOMEWORK ASSIGNMENT:
   - 3.1 Partially done at conclusion of each SEGMENT
   - 3.2 Marked by instructor on RESPONSE DEVICE when completed
   - 3.3 Analyzed by computer

4. TEST A: ("AFTER" TEST)
   - 4.1 Test similar to TEST B
   - 4.2 Test on MBO's of entire volume
   - 4.3 RESPONSE DEVICE submitted
   - 4.4 Analyzed by computer
   - 4.5 REMEDIAL PRESCRIPTIONS provided by computer
   - 4.6 Students above cut-off point move to next VOLUME

5. 5.1 Student scoring below cut-off point reports for individual or group instruction (live)
   - 5.2 Available support materials arranged
   - 5.3 G.M.I. SESSIONS scheduled by computer


STUDENT ACTIVITY FLOW CHART
PLAN B
V + 1
PRE-TEST--VOL. V
PORT-A-PUNCH
TEST B
COMPUTER SCORED
SCORE > M
NO?
YES?
STUDY GUIDE
VOLUME - V
SEG - S
READING
NOTES
CORE TEXT
ENR. TEXT
QUESTION Q
ANSWER CHOICE
PROGRAM CONTROL
ANSWER MATRIX S
SEG S
COMPUTER
REM PAGE
ANS OK?
NO ?
Q= Q+1
END SEG ?
NO ?
TURN IN PUNCH CARD
S= S+1
END VOL ?
NO ?
TURN IN CARD
PORT-A-PUNCH
HOMEWORK ASSIGNMENT
ANALYSIS BY INSTRUCTOR
H.W. V
POST TEST A
PORT-A-PUNCH
TEST A
SCORED
REM TEXT
REMEDIAL PRESCRIPTION
SCORE < P
NO?
YES?
SCORE > N
NO?
YES?
REMEDIAL INSTRUCTION
REVIEW BY INSTRUCTOR

STUDENT ACTIVITY

1. The chart on the facing page itemizes the differentiated learning activities that the student experiences in the PMC and correlates them with the:

   Text
   Software component
   Input interface
   Computer printouts

2. The PMC is keyed to the individualization of the learning process through self-pacing in the following areas:

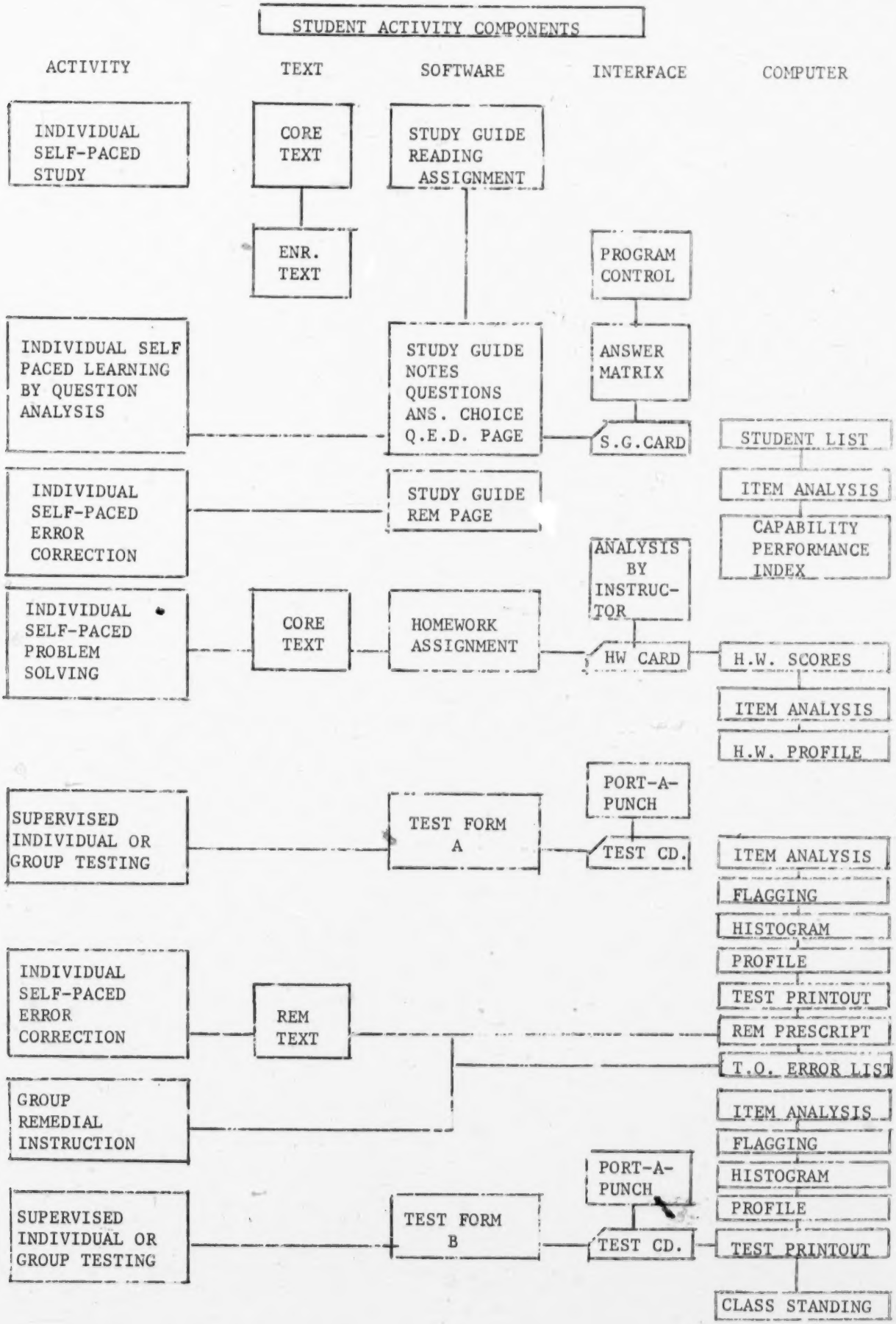
   Study
   Question analysis
   Error correction
   Problem solving
   Testing
   Remedial instruction

3. Group activities complement the individualization in:

   Group remedial instruction
   Group testing

4. Supplementary General sessions can offer:

   Orientation
   Enrichment
   Summarization


STUDENT ACTIVITY COMPONENTS
ACTIVITY
TEXT
SOFTWARE
INTERFACE
COMPUTER
INDIVIDUAL SELF-PACED STUDY
CORE TEXT
STUDY GUIDE READING ASSIGNMENT
ENR. TEXT
PROGRAM CONTROL
INDIVIDUAL SELF PACED LEARNING BY QUESTION ANALYSIS
STUDY GUIDE NOTES QUESTIONS ANS. CHOICE Q.E.D. PAGE
ANSWER MATRIX
S.G.CARD
STUDENT LIST
ITEM ANALYSIS
CAPABILITY PERFORMANCE INDEX
INDIVIDUAL SELF-PACED ERROR CORRECTION
STUDY GUIDE REM PAGE
ANALYSIS BY INSTRUC-TOR
INDIVIDUAL SELF-PACED PROBLEM SOLVING
CORE TEXT
HOMEWORK ASSIGNMENT
HW CARD
H.W. SCORES
ITEM ANALYSIS
H.W. PROFILE
PORT-A-PUNCH
SUPERVISED INDIVIDUAL OR GROUP TESTING
TEST FORM A
TEST CD.
ITEM ANALYSIS
FLAGGING
HISTOGRAM
PROFILE
TEST PRINTOUT
INDIVIDUAL SELF-PACED ERROR CORRECTION
REM TEXT
REM PRESCRIPT
T.O. ERROR LIST
GROUP REMEDIAL INSTRUCTION
ITEM ANALYSIS
FLAGGING
HISTOGRAM
PROFILE
PORT-A-PUNCH
SUPERVISED INDIVIDUAL OR GROUP TESTING
TEST FORM B
TEST CD.
TEST PRINTOUT
CLASS STANDING

PROGRAMMED MATHEMATICS CONTINUUM

LEVEL I

HAND BOOK

CHAPTER III

PRINCIPLES AND PROCEDURES SUGGESTED

- FOR REPLICATION

PRODUCTION OF THE STUDY GUIDE

This is the chronological sequence that should be followed by the writer.

PRELIMINARY ACTIVITY:

REFERENCE PAGE NO.:

1. Read parts of SYLLABUS relating to the SEGMENT (SEG)

2. Read MEASURABLE BEHAVIORAL OBJECTIVES LIST (MBO LIST)

   2.1 Check MBO list against SYLLABUS for validity

   2.2 Enter MBO codes on MBO CROSS REFERENCE LIST (CROSS REF) (75)

3. Read pages of CORE TEXT relating to MBOs

   3.1 Write READING ASSIGNMENT

   3.2 Check concepts in CORE TEXT against MBO LIST

   . 3.21 Note omissions in CORE TEXT

   3.22 Note omissions in MBO LIST

4. Read pages of ENRICHMENT TEXT relating to MBOs

   4.1 Check for concepts omitted from CORE TEXT

   4.2 Note alternate explanation of concepts

   4.3 Note items suitable for motivational references.

BACKGROUND MATERIAL:

REFERENCE PAGE NO.:

5. Write SUPPLEMENTARY NOTES (NOTES)

   5.1 Check NOTES for coverage of MBOs omitted from CORE TEXT

   5.2 Give alternate explanation of difficult concepts

6. Write NOTEBOOK INSTRUCTIONS

   6.1 List definitions

   6.2 List formulas

7. Outline a lesson plan for SEG

   7.1 Relate each step to an MBO

   7.2 Re-order MBO LIST according to lesson plan

   7.3 Consider developmental sequence

   7.4 Group ENABLING OBJECTIVES (EOs) supporting TERMINAL OBJECTIVES (TOs)

STUDY GUIDE MANUSCRIPT:

8. Write a QUESTION-PROBLEM for each MBO in multiple-choice form, 4 choices (57

   8.1 Enter question number on MBO Cross Reference List (75)

   8.2 Determining LEARNING CATEGORY (LC) (52)

      8.21 Choose appropriate BEHAVIORAL VERB (52)

      8.22 Enter LC on MANUSCRIPT ANSWER MATRIX (AMX) (65)

9. Solve Problem - specify ANSWER

   9.1 Determine probable errors

   9.2 Choose DISTRACTORS

   9.3 Relate DISTRACTORS to CATALOG CODE

   9.4 Choose ANS - DISTRACTOR array permutation for multiple choice format

REFERENCE PAGE NO.:

10. Choose DISTRACTOR STRATEGY (59)

10.1 Write REMEDIAL page according to STRATEGY for DISTRACTOR

10.2 Enter REM code on AMX (65)

10.3 Enter DISTRACTOR STRATEGY CODE ON AMX (59)

10.4 Complete DISTRACTOR STRATEGY FLOWCHART (61)

11. Prepare HOMEWORK ASSIGNMENT (HW) for SEG (73)

11.1 Allot one fifth of the HOMEWORK ASSIGNMENT FOR VOLUME to each of the 5 SEGs

11.2 Relate to TOs of MBO LIST

11.3 Enter QUESTION NUMBER on MBO CROSS REFERENCE LIST (75)

TEST CREATION:

12. Write POST TEST (FORM A) 10 QUESTION-PROBLEMS use TEST QUESTION work sheet (68)

12.1 Relate each question to TOs of MBO list

12.2 Enter QUESTION NUMBER on MBO CROSS REFERENCE LIST (75)

12.3 Enter MBO code on TEST ANSWER MATRIX (69)

12.4 Solve PROBLEMS

12.5 Determine probable errors

12.51 Choose 4 DISTRACTORS per QUESTION

12.52 Enter CONCEPT CATALOG CODE for each DISTRACTOR choice

12.6 Choose ANS-DISTRACTOR array permutation

12.61 Enter array on TEST ANSWER MATRIX (59)

12.62 Enter CONCEPT CATALOG CODE for each DISTRACTOR choice

12.7 Choose REMEDIAL PRESCRIPTION from REMEDIAL TEXT for each DISTRACTOR choice

12.71 Enter PRESCRIPTION on TEST ANSWER MATRIX (69)

12.8 Enter LEARNING CATEGORY on TEST ANSWER MATRIX (52)

REFERENCE
PAGE NO.:

13. Write POST TEST (FORM B) 10 QUESTION PROBLEMS (67)

use TEST QUESTION work sheet

13.1 Create a VALID parallel test

13.11 Retain form by substitution of equivalent numbers and letters

13.12 Retain exact concept

13.2 Re-order the question numbers

13.3 Follow same steps as outlined for Test A 12.1 - 12.6

13.4 Remedial Prescription is omitted

EVALUATION:

14. Examine MBO CROSS REFERENCE LIST for thorough coverage allotment of MBO to: (74)

14.1 SG questions

14.2 HW assignment

14.3 Test A

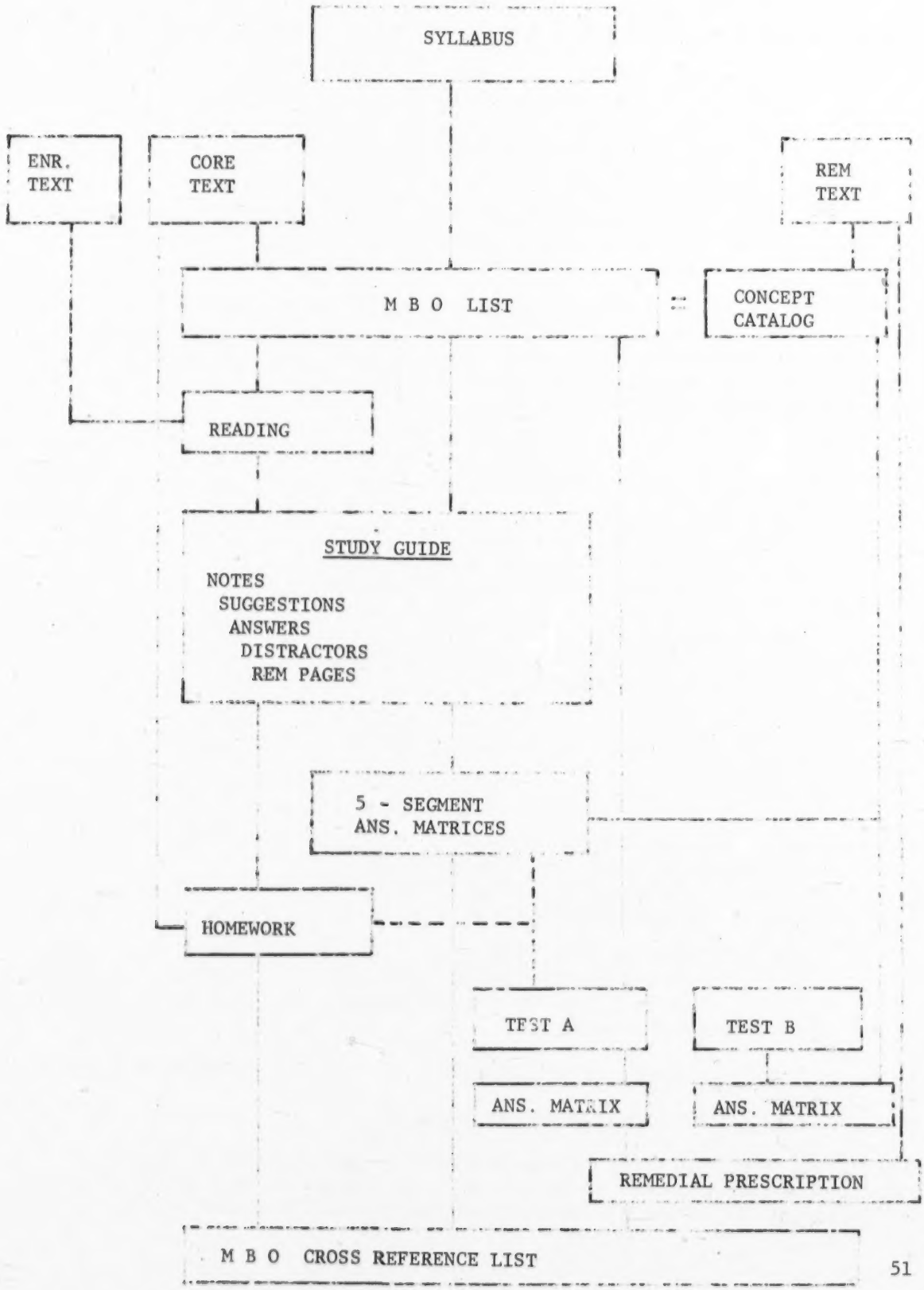
14.4 Test B

15. PROOF READ all copy.

COURSE COMPONENTS

16. The diagram on the facing page is a schematic summary of the components of the course (just previously described) as they are met by the course writer.

COMPONENTS FOR STUDY GUIDE CREATION



LEARNING CATEGORIES

The course writers prepare questions for the five areas of instruction and testing:

1. STUDY GUIDE - MBO LIST
2. HOMEWORK ASSIGNMENTS
3. TEST A
4. REMEDIAL ASSIGNMENT
5. TEST B

For research purposes it is required that each question be classified according to the categories listed. As an aid to determining the classification, it is required that the verb chosen be from the limited list.

In general, the questions in a given segment will be arranged in the same order as their rank starting from level one, "definition", and progressing through "computation" , "analysis" , "deduction" , "synthesis" , and "extrapolation" . By constant reference to the chart an unusually high concentration of question types of any one particular level can be avoided.

LEARNING CATEGORY	SYMBOL	DEFINITION	BEHAVIORAL VERB ASSIGN. PRIMARY	SECONDARY
1	RR	RECALL AND RECOGNITION STATEMENT OF FORMULA STATEMENT OF RULE OF OPERATION DEFINITION OF A MATHEMATICAL CONCEPT	DEFINE	RECOGNIZE
2	BM	BASIC COMPUTATION FUNDAMENTAL ARITHMETIC OPERATIONS USE OF TABLES	PERFORM ADD SUBTRACT MULTIPLY DIVIDE FIND ROOT RAISE TO POWER INTERPOLATE	CHECK
3	AN	ANALYSIS OF PRINCIPLE CHOICE OF APPLICABLE FORMULA SELECTION OF PROPER FORMULA CHOICE OF STRATEGIES	STATE	CHOOSE
4	DD	DEDUCTION FROM PRINCIPLE PROPER APPLICATION OF PRINCIPLE LOGICAL STEP-BY-STEP PROCEDURE EVALUATION	PROVE DERIVE SOLVE FOR	APPLY CONSTRUCT SUBSTITUTE
5	SN	SYNTHESIS TO PRINCIPLE	DETERMINE	RELATE
6	XT	EXTRAPOLATION BEYOND PRINCIPLE	PROPOSE	

TEST QUESTIONS SHOULD BE KEYED TO THE APPROPRIATE LEVEL BY CAREFUL CHOICE OF THE BEHAVIORAL VERBS ASSIGNED TO THAT LEVEL. THE WEIGHT OF EACH QUESTION SHOULD BE DETERMINED BY THE LEVEL OF DIFFICULTY AS EXHIBITED IN THE CHART ABOVE.

QUESTION PLACEMENT CORRELATION STRATEGY:

There are five avenues for questioning specific MBO's; namely, the Pre-Test, Study Guide, Homework, Post Test, and Remedial Prescriptions. The synthetic charts below correlate the Learning Difficulty of the question with the sequence of Enabling Objectives (EO) and Terminal Objectives (TO) and when viewed together indicate the multiple checking of the several criteria as employed in the separate media.

TEST B:

			L.C.									
Learning Category Range:		3 - 4	6									
MBO SELECTION:	EO:	Some	5									
	TO:	All	4				*					*
			3			*		*		*		*
			2			*		*		*		*
			1			*		*		*		*
			MBO:	11	12	13	14	10	21	22	23	20
				EO	EO	EO	EO	TO	EO	EO	EO	TO

STUDY GUIDE:

			6									
			5									
Learning Category Range		1 - 4	4				*	*			*	*
	EO:	All	3			*	*	*			*	*
	TO:	All	2		*	*	*	*		*	*	*
			1	*	*	*	*	*	*	*	*	*
			MBO:	11	12	13	14	10	21	22	23	20
				EO	EO	EO	EO	TO	EO	EO	EO	TO

HOMEWORK ASSIGNMENT:

Learning Category Range		4 - 6	6					*				
	EO:	Some	5				*	*			*	*
	TO:	All	4				*	*			*	*
			3				*	*			*	*
			2				*	*			*	*
			1				*	*			*	*
			MBO:	11	12	13	14	10	21	22	23	20
				EO	EO	EO	EO	TO	EO	EO	EO	TO

TEST A:

Learning Category Range:		3 - 4	6								
MBO Selection:	EO:	Some	5								
	TO:	All	4				*			*	
			3			*	*		*	*	
			2			*	*		*	*	
			1			*	*		*	*	
			MBO:	11	12	13	14	10	21	22	23	20
				EO	EO	EO	EO	TO	EO	EO	EO	TO
			L.C.									

REMEDIAL PRESCRIPTION:			6								
Learning Category Range:		1 - 4	5								
MBO Selection:	EO:	All	4					*			*
	TO:	All	3			*	*	*		*	*
			2		*	*	*	*		*	*	*
			1	*	*	*	*	*	*	*	*	*
			MBO:	11	12	13	14	10	21	22	23	20
				EO	EO	EO	EO	TO	EO	EO	EO	TO

The coverage of the MBO's varies from one course component to another. In general, the fundamental EO's are explored in the Study Guide and Remedial Prescriptions; while the more important EO's and all the TO's are covered in every component.

The Learning Level of difficulty varies with the lowest being employed in the Remedial Prescriptions and Study Guide, while the highest are reserved for the Homework Assignment.

THE QUESTION MODE:

The outstanding characteristic of the PMC is its fundamental dependence upon the QUESTION as the thought director device. The lengthy didactic presentation is avoided.

THE READING

The READING refers the student to a standard presentation in a recognized textbook, and this is supplemented by additional notes in the beginning of each SEGMENT. Nevertheless, the chief strategy is the carefully devised question.

Questions appear in:

The Pre Test (Test B)
The Study Guide
The Homework Assignment
The Post Test (Test A)

Except for the HOMEWORK ASSIGNMENT (which, in the present course, is a reference to standard questions as presented in the CORE TEXT and which are marked subjectively by the instructor later to be recorded by the computer) the questions are in multiple choice form and are created by the course writer.

The essential difference between the test questions in both test forms and the STUDY GUIDE questions is in the treatment that the incorrect answer receives.

THE PRETEST (TEST B)

The PRE TEST (TEST B) incorrect answers are merely tallied by the computer in the process of grading the student's prior knowledge of the material in the related VOLUME. Item analysis and Histogram printouts as well as correlations with similar results in the POST TEST (FORM A) are made by the computer. Each question is keyed to an MBO.

THE POST TEST (TEST A)

The POST TEST (TEST A) has a detailed analysis of each DISTRACTOR relating it to a CATALOG NUMBER. Each incorrect choice is accompanied by a particular REMEDIAL PRESCRIPTION drawn from the REMEDIAL TEXT. The computer has several routines described in other parts of this report that analyze the students' response patterns.

THE STUDY GUIDE

The STUDY GUIDE has the most detailed analysis of each response. Not only is each question related to a Learning Category and an MBO, but each DISTRACTOR is accompanied by a detailed analysis of the cause of the error with hints or direct aids for the student to effect the proper solution.

The following pages outline one phase of this area, that of question creating and the detailed analysis of the relationship to the appropriate MBO, the appropriateness of the distractors offered, etc., as discussed more completely in the TEST EVALUATION CHECK LIST on Page 70.

PRINCIPLES OF CREATING A SET OF CRITERION CHECKS

COUNTABILITY REQUIREMENT:

The course design requires a statistical analysis of the responses made by each student to each criterion check in the

PRE-TEST
STUDY GUIDE
POST-TEST

for correlation with background information and individual remedial prescriptions. The responses are summarized for an item analysis of question-response experience by the entire population for

COURSE OPTIMIZATION
GENERAL REMEDIAL SESSION ORGANIZATION

OBJECTIVITY REQUIREMENT:

An off-line operation cannot accept unanticipated responses and relate them to a particular list of concepts for error analysis. However, a predicted set of typical errors (referred to as DISTRACTORS) can be devised for each question. Therefore, each QUESTION is related to a specific MEASURABLE BEHAVIORAL OBJECTIVE by coded number. Each DISTRACTOR is related to a coded CONCEPT CATALOG entry.

MULTIPLE CHOICE FORMAT:

To maintain control over the student's response patterns, each question is cast into the MULTIPLE CHOICE format.

Certain precautions must be taken to avoid the major objection made to multiple choice question-answer arrays, that of telegraphing the answer.

1. The problem worksheets for the STUDY GUIDE and TESTS (see Pages 62, 67) indicate that each problem must be created to illustrate and test a specific MBO .

2. Each step of the solution must be examined for the possibility of the occurrence of a typical error. The error identified by CONCEPT CATALOG must be incorporated into the solution. This solution becomes a DISTRACTOR.

3. If DISTRACTORS are chosen without a specific error in mind, the accuracy of analysis is affected.

4. Other devices to disguise the actual value of the DISTRACTOR to avoid frustrating the purpose of the problem by merely substitution of the various choices can be employed, as for example:

   x is one member of the set $\{ 17, 19, 21, 23, 25 \}$

   y is a negative number > -17

   a is larger than b

   c is a prime number

   $10 < d < 20$

   e is odd and f is even.

5. If it is found that the number of distractors that can be properly assigned to a particular question exceeds four (not including the answer) it is advised to replace one of the distractor choices with the all inclusive, "NONE OF THESE" and to test the same MBO in a subsequent question with a different array of distractors. The cross referencing made possible by this strategy will produce a meaningful result.

6. If it is found that the question chosen to illustrate a specific well-defined principle is so elementary that only one or two distractors can be devised, it is suggested that two such questions be combined into one problem with the truth values of each paired into four combinations.

DISTRACTOR STRATEGY:

The design of the Study Guide with its scrambled pagination (see Pages 7 -31) and with the questions structured in a multiple choice format presents an answer array to the student of four choices; one, the correct answer and the other three, incorrect. The three incorrect are devised to illustrate the outcome resulting from a typical misapplication of a fundamental principle and as such are referred to as

DISTRACTORS.

The course writer has several options available for the handling of the answer choices.

STRATEGY A:

The correct answer choice is referred to a page where the simple statement, "Your answer choice is correct, please proceed to the next question below." This strategy is generally reserved for questions with a Learning Category level of 1, 2, or 3.

Each of the DISTRACTORS is referred to a separate page (OK PAGE) (REM PAGE) where the error is explored in detail and then the student is advised to "Return to page __ and reconsider the question."

STRATEGY B:

The correct answer is handled by an OK PAGE as in STRATEGY A. But because of the similarity of the nature of the mistakes exhibited in the DISTRACTORS, two or all three of the incorrect choices are handled by the same comments, and so they are referred to only one or two REM PAGES.

STRATEGY C:

The correct answer choice is referred to a page (Q.E.D. PAGE) where a complete review of the solution is exhibited for the student's benefit. This will reinforce the student's understanding of the principles and processes involved and demonstrate an approved method of solution. This strategy is applied to questions with a Learning Category above Level 3.

Each of the DISTRACTORS is referred to a separate REM PAGE as in STRATEGY A.

STRATEGY D:

The correct answer choice is referred to a Q.E.D. PAGE as it is done in STRATEGY C.

The incorrect answers are referred to only one or two REM PAGES as in STRATEGY B, and for the same reasons.

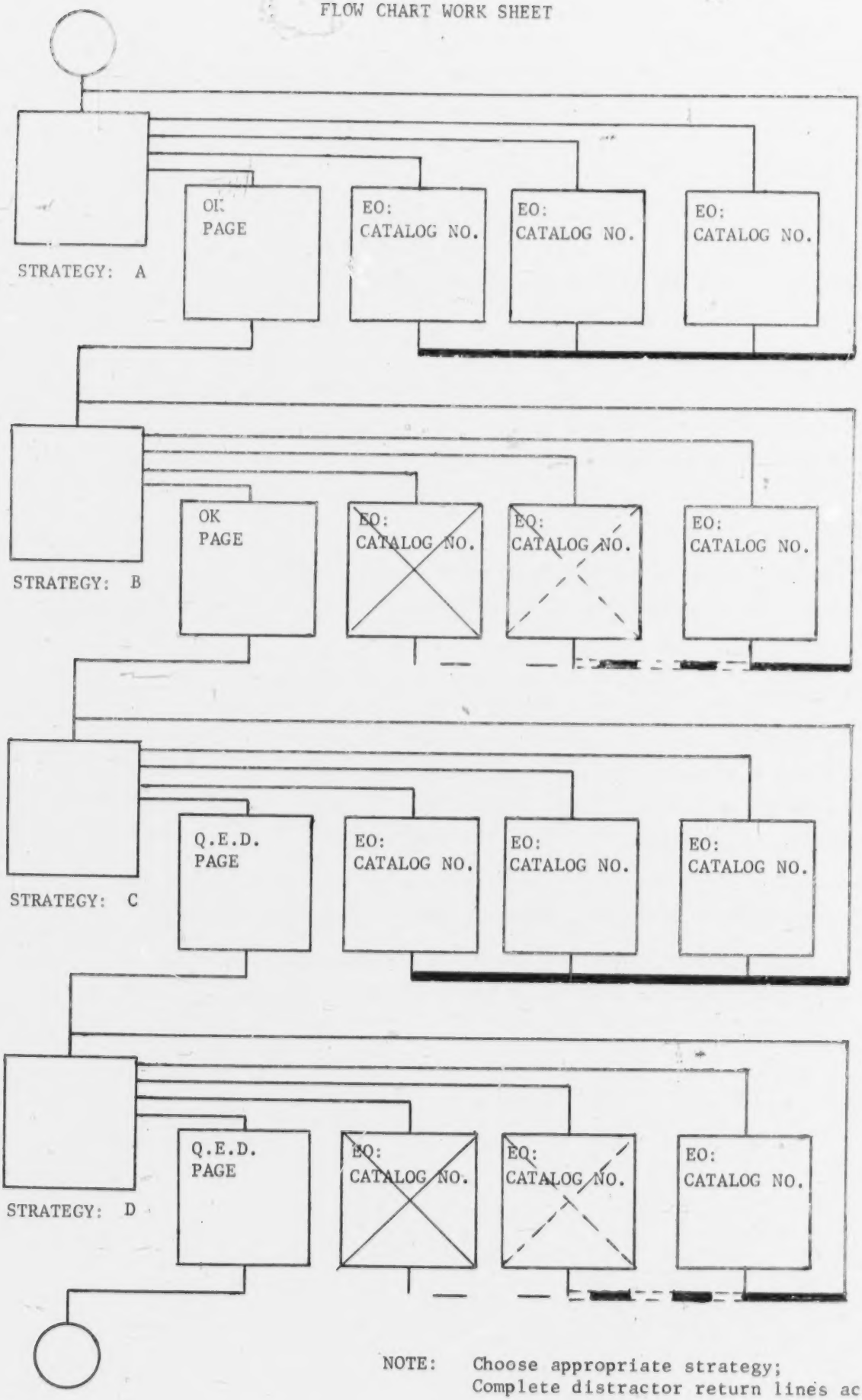
This analysis can be summarized in chart form:

STRATEGY	CORRECT ANSWER	DISTRACTORS
A	O.K. PAGE	Separate REMS
B	O.K. PAGE	Combined REMS
C	QED PAGE	Separate REMS
D	QED PAGE	Combined REMS

DISTRACTOR STRATEGY FLOW CHART:

The form on the facing page is designed to allow the course writer to illustrate the sequence of the student's response activity with a minimum amount of construction. The form has dotted lines which can be adjusted to follow the particular strategy chosen for each question. The MBO for each QUESTION and the EO and CATALOG NUMBER are to be placed in the appropriate boxes provided.

FLOW CHART WORK SHEET



NOTE: Choose appropriate strategy;
Complete distractor return lines accordingly

STUDY GUIDE QUESTION CREATION

MBO REFERENCE:

The question must be created to exhibit a specific MBO. This must be noted on the form opposite along with the actual statement of the MBO. If a text was the source, then this is to be noted for reference.

LEARNING CATEGORY:

The question must be phrased to indicate the appropriate Behavioral Verb associated with the level of difficulty.

SOLUTION:

The problem must be solved step-by-step with detailed explanations if the answer is to be handled by a QED PAGE.

DISTRACTORS:

The distractor must be chosen by examining the solution for steps that generally result in misapplications of principles. They must be realistic errors. REM PAGES must be written to give the required remedial aid to the student.

The permutation of the positioning of the four choices must be randomly made to avoid the appearance of a patterned answer array.

This form is a work sheet, and the final information is later incorporated into the STUDY GUIDE answer matrix.

STUDY GUIDE

QUESTION WORK SHEET: _____

RELATED TO MBO: _____

MBO STATEMENT: _____

_____

STATEMENT OF QUESTION:

SOURCE: BOOK: _____

PAGE: _____

SOLUTION: AUTHORITIES (EO)

(+) QED PAGE TO BE WRITTEN

DISTRACTORS: AUTHORITIES IGNORED: MISAPPLIED

(A)

*

(B)

*

(C)

*

DISTRACTOR STRATEGY * REM PAGE TO BE WRITTEN

APPROVED: _____ CHECKED: _____ WRITER: _____

STUDY GUIDE MANUSCRIPT ANSWER MATRIX:

The form on the facing page was devised to record the information necessary for the scrambled pagination and for the answer matrix for the program control as well as the information necessary for the computer study guide analysis.

LEARNING CATEGORY:

The level of difficulty of each question is noted. This allows a computer analysis which correlates the question difficulty response against any item of the background information on each student or the entire population enrolled in the course.

DISTRACTOR STRATEGY:

The analysis of the error rate on each type of distractor strategy will indicate which study guide REM PAGES will have to be re-written because of unusual frequency of errors recorded.

BEHAVIORAL OBJECTIVES:

The correspondence of each question to each MBO and whether it is a TO or an EO is noted. This information is made available for computer analysis. It is also recorded on the MBO CROSS REFERENCE SHEET (see Page 68).

ANSWER CHOICE:

The CORRECT ANSWER and the REM PAGES are recorded under the selected answer permutation. This allows for a randomizing of the answer choice pattern to foil the discovery of any "pattern" in the answer choice array.

CATALOG NUMBER:

The CATALOG NUMBER giving the generic description of the cause of the error is recorded. This will also appear in the computer PRINTOUT for easy referencing of error incidence.

SCRAMBLED PAGINATION:

This becomes the work sheet for the process of scrambling the pages of the STUDY GUIDE. Reference is made to Pages 71 to 75 for a detailed account of the procedure.

STUDY GUIDE

VOL ____ SEG ____ ANSWER MATRIX

QUESTION:

LEARNING CATEGORY:

			DISTRACTOR STRATEGY: BEHAVIORAL OBJ. TO:	EO:	A	CAT. NO.	B	CAT. NO.	C	CAT. NO.	D	CAT. NO.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												

MANUSCRIPT PAGINATION

FINAL SCRAMBLED PAGINATION

1.	DEFINE	RECOGNIZE
2.	PERFORM	CHECK
3.	STATE	CHOOSE
4.	PROVE	APPLY
5.	DETERMINE	RELATE

TEST QUESTION WORK SHEET:

REFERENCE PAGE NO.:

This sheet should be completed in such detail that another writer could follow all of the reasoning involved in the question - answer - distractor decisions.

1. The test number should be entered.

2. The question number should be entered.

3. The MBO NUMBER relating to the question should be entered.

4. The complete MBO STATEMENT should be added after the lead, "The student should be able to..."

5. The TEST QUESTION should be stated completely. Reference should be made to form QUESTION PLACEMENT CORRELATION STRATEGY for the rationale of the EO, and TO criterion checks and choice of question difficulty. (53)

6. The LEARNING CATEGORY should be indicated. Reference should be be made to form entitled "LEARNING CATEGORIES" for the proper choice of the BEHAVIORAL VERB. (52)

7. The ACTUAL COMPUTATION involved in the arrival at the erroneous answer should be made.

8. The MBO relating to the error should be entered.

9. The REMEDIAL PRESCRIPTION should be carefully chosen to present proper practice work in the deficiency area. Book, page, and problem numbers should be indicated. A ten minute assignment for each error is considered normal.

10. The DISTRACTOR STRATEGY should be chosen after the problem with its solutions and distractors has been completed. (59)

11. The work must be checked by the editor.

12. The complete material should be approved by the Project Coordinator.

TEST QUESTION WORK SHEET:

TEST:_____

QUESTION:_____

RELATED TO MBO_____

WRITER:_____

THE STUDENT SHOULD BE ABLE TO:_____

LEARNING CATEGORY:_____ DISTRACTOR SEQUENCE:_____ SOURCE BOOK:_____ PAGE:_____

STATEMENT OF TEST QUESTION:	ANSWER CHOICE		REMEDIAL PAGE: PRESCRIPTION PROBLEM:
SOLUTION:			
DISTRACTOR 1		CATALOG NUMBER	
DISTRACTOR 2		CATALOG NUMBER	
DISTRACTOR 3		CATALOG NUMBER	
DISTRACTOR 4		CATALOG NUMBER	

APPROVED:_____ CHECKED:____

THE TEST ANSWER MATRIX

This form comprises the information that is forwarded to the computer as a basis for the test marking function. It is used for both forms of the test.

The LEARNING CATEGORY and MBO associated with each question is indicated.

The CATALOG NUMBER, with its brief description, is related to each DISTRACTOR.

The REMEDIAL PRESCRIPTION, (which will be part of only the POST TEST (TEST A) printout is indicated. It becomes part of the course master file of the computer memory.

TEST ANSWER MATRIX FOR COMPUTER INPUT

PMC VOLUME: ___ TEST: A or B COMPUTER TEST: _____

QUES	LC	MBO	ANS	CAT. NO.	DESCRIPTION	REMEDIAL PRESCRIPTION
			A			
			B			
1			C			
6			D			
			E			
			A			
			B			
2			C			
7			D			
			E			
			A			
			B			
3			C			
8			D			
			E			
			A			
			B			
4			C			
9			D			
			E			
			A			
			B			
5			C			
10			D			
			E			

TEST EVALUATION:

The form on the facing page is a compact check list of items that must be evaluated by the course editor before approval of the test.

MBO REFERENCES:

Each question and each of the DISTRACTORS must be properly related to the MBO intended. They should be designed to test the specific objective precisely.

MATHEMATICAL CONSIDERATIONS:

The language level employed, the accuracy of terminology, the adequacy of instructions and diagrams, must be examined and approved.

The array of answer choices, the permutation of correct answer placement, and the presentation of realistic distractors must also be considered.

The remedial prescriptions must be analyzed for their relevance.

Every problem must be solved, and its answer verified before final approval is given.

TEST EVALUATION CHECK LIST

GOOD +

TEST # _____

POOR -

VOL _____ TEST A or TEST B

QUESTION	1	2	3	4	5	6	7	8	9	10
M.B.O. REFERENCE										
MATH TERMINOLOGY										
LANGUAGE LEVEL										
LEARNING CATEGORY										
QUESTION STYLE										
QUESTION FORMAT										
INSTRUCTIONS GIVEN										
DIAGRAM OFFERED										
ANSWER CHOICE										
VALID ANSWER										
ANSWER MATRIX										
DISTRACTOR 1 REALISTIC										
CAT. REFERENCE										
PRESCRIPTION										
DISTRACTOR 2 REALISTIC										
CAT. REFERENCE										
PRESCRIPTION										
DISTRACTOR 3 REALISTIC										
CAT. REFERENCE										
PRESCRIPTION										
DISTRACTOR 4 REALISTIC										
CAT. REFERENCE										
PRESCRIPTION										

PREPARED BY:

HOMEWORK ASSIGNMENT WORK SHEET:

On the facing page is the form used by the course writer for the recording of the problems chosen for the HOMEWORK ASSIGNMENT.

One strategy is to have the CORE TEXT used as a source of problems for this assignment. In this way the student is subtly influenced to re-read the basic text. The problems should be chosen with great care and in an increasing order of difficulty.

MBO REFERENCE:

Each question must be chosen to correspond to a particular MBO. Complete coverage of the MBOs is more likely to be achieved when specific notation must be made. Refer to Page 53 for the principles of question placement and to Page 74 for an overview discussion of the MBO cross reference sheet.

TEXT INDEPENDENCE:

To achieve a degree of independence from any one particular textbook, the course writers could devise a list of homework problems specifically created for the MBO criterion check. However, this form would still serve the purpose as a check on the completeness of coverage.

HOMEWORK ASSIGNMENT

VOLUME NO. _____

BOOK: _____

HOMEWORK QUESTION NO.	PAGE NO.	EXAMPLE NUMBER	MBO REFERENCE
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

MBO STRATEGY AND CROSS REFERENCE SHEET:

The purpose of this form is to record the spread of questions under the four media across the MBO list.

Reference is made to the QUESTION PLACEMENT CORRELATION STRATEGY on Page 53 for further analysis.

The major consideration is to have each MBO covered by at least one question in some media form. The preparation of this cross referencing form is the last action in the creation of the program. If, however, it is maintained while the course is being created, an even distribution of MBO coverage will be achieved.

MBO STRATEGY AND CROSS REFERENCE SHEET

REFERENCE MADE TO QUESTION NUMBER:

MBO NUMBER:	CATALOG NUMBER	S G	H W	PRE TEST	POST TEST

75/76

SCRAMBLED PAGINATION FOR STUDY GUIDE

1. INTRODUCTION

1.1 The purpose of the STUDY GUIDE (SG) is to direct the student in his reading of a recognized textbook without the supervision by a teacher being necessary (although there may be provision for a teacher - classroom format used as part of the overall learning program.)

1.2 In essence, the SG format consists of Supplementary Notes, Reading Assignments, Homework Assignments, A V References and a battery of Questions.

1.3 The questions are presented in multiple choice form with provision for tracking the student's answer patterns by means of a punch card record and a device known as a Program Control. Both the question and the answer choices are keyed to a finely devised list of measurable behavioral objectives that comprise the course content.

1.4 Each answer choice is discussed in some detail.
If the answer chosen is wrong, the student is referred to the question again (REM PAGE)

If the choice is correct, he is either referred to the next question without comment (OK PAGE) or with a presentation of the complete solution (QED PAGE).

1.5 The elements of this BRANCHING PROGRAM are therefore:
QUESTION, REM, OK and QED

2. DESCRIPTION

2.1 To allow the student to answer each QUESTION, only after he answers the precious question correctly, the PROGRAM CONTROL directs him to a page where he discovers whether or not he is correct. By having these pages in a scrambled order, he is unable to locate the answer to the questions by merely turning the pages of the book. The only identification of the answer pages is made through the PROGRAM CONTROL and the ANSWER MATRIX. This page number is hidden from view until a punch card entry is made on the PROGRAM CONTROL.

2.2 By placing each question after the OK or the QED, the student is forced to arrive at the correct answer for the previous problem before he can even find the following question.

2.3 Since, in general the REMS are less than one-half of a page, in length, further scrambling is effected by placing two unrelated REMS to a page.

3. COMPONENTS

There are four components that are involved in the recording of the scrambling pages.

3.1 ANSWER MATRIX — This form (giving the manuscript numbering system for the four answer choices for each question of a SEG and indicating the correct choice as a check or as a QED) is complete for the page assignment.

3.2 PAGINATION MATRIX: — This form is blank. On it the assignment of REMS will be entered. The top half of the page will be designated as /1 and the bottom as /2.

3.21 — Questions will be indicated by SEG and Question: e.g. Segment 2, Question 6 will be coded: 2-6.0

3.22 — REM pages will be indicated by SEG, Question and Answer choice; e.g. Segment 2, Question 5, Answer Choice 4 will be coded: 2.5.4 (note decimals).

3.3 QUESTION SHEET: — Each question (capable of standing alone) is on a sheet with generous spacing between questions to allow for separating the questions after the scrambled page entries have been made. Each question must present four answer choices. Each answer choice must be related to a REM (not necessarily different, dependent upon the strategy chosen).

3.4 REM PAGES: — Each Answer choice is referred to a REM, of which there are three types:

3.41 Wrong Answer: There is a comment followed by the direction to return to the question and choose another answer.

3.42 Check: This is a simple statement that the answer choice was correct. There is a direction to proceed to the next question which follows immediately and which shares the same half page.

3.43 The QED: This is a presentation of a complete solution to the problem. It is followed by the direction to proceed to the next problem which is presented below it. The QED must, therefore, be in the upper half of the page, with the following question in the lower half.

4. PROCEDURE

4.1 PAGECOUNT:
Determination of number of pages required:

Multiply the number of questions by 4.
Add the number of QEDS
Add the number of special pages.
Subtract the number of duplicate REMS
Divide this number by 2

4.2 Begin with Question 1-1, continue with the REMS for question 1 and then go on to Question 2 and the REMS for 2, and so on.

In general assign one question to one decade, or row of pages, the first REM to the next decade, the second REM to the following decade, and so forth.

4.3 ENTRIES:

TYPE ENTRY	WHERE ENTERED
QUESTION PAGE NUMBER	QUESTION SHEET-next to question EACH REM PAGE in "return space"
REM PAGE NUMBER	ANSWER MATRIX-under REM number REM PAGE-next to the REM
QUESTION NUMBER	PAGINATION MATRIX-under page number REM PAGE-after an OK REM PAGE-after a QED
REM NUMBER	PAGINATION MATRIX

4.4 SEQUENCE OF OPERATIONS:

4.41
1. Put question number on PAGINATION MATRIX under a certain page.
2. Put the page number next to the question on question page.
3. Put that same page number on all related REM PAGES in the space indicated in the phrase, "return to page ___ and try the question again "

NOTE: (a) If the previous REM was an OK(i.e., it was a simple statement that the answer was correct with no other explanation) then the following question should share the same half page.

(b) If the Previous REM was a QED (i.e it was a a correct choice and was supported by a complete solution) then the following question should be placed in the lower half of the page. Such QEDS must, therefore, be placed in only the upper half of the page.

4.4 SEQUENCE OF OPERATIONS:
(Continued)

4.41 4. Put REM NUMBER on PAGINATION MATRIX under a certain page.

(Note: Each REM should be located several pages away from the QUESTION and the other related REMS.)

5. Put the PAGE NUMBER next to the REM on the REM PAGE

6. Put the same PAGE NUMBER in the ANSWER MATRIX under the proper REM NUMBER

5. EXAMPLES OF THIS PROCEDURE are now given. Please refer to the illustrations on the following page.

5.1 REM 2.4.4 was a "CHECK" and had been assigned to page 51 at the top.

2.4.4 was placed on the PAGINATION MATRIX in the top half of row 5 under 1.

On the REM PAGE 2.4.4 the page number $\frac{51}{1}$ was written

5.2 QUESTION 2-5 shares the same half page with the previous REM (since REM 2.4.4 was a CHECK)

2-5 was placed on the PAGINATION MATRIX in the top half of row 5 in the column headed 1.

On the QUESTION PAGE the page number, $\frac{51}{1}$ was written after QUESTION 2-5.

On each of the REMS for Question 2-5, where the answer choice was wrong, the page $\frac{51}{1}$ was written in the space provided in the instruction, "Return to...and choose another answer. (See page 2.5.4)

5.3 REM 2.5.4 was placed on page $\frac{61}{1}$; the entry "2.5.4" was made on the PAGINATION MATRIX and $\frac{61}{1}$ was written next to that REM on the REM PAGE. This same entry was made on the ANSWER MATRIX under "D" in row "5".

5.4 The correct answer 2.5.3 was a QED. As such it required a complete half page and had to be placed in the top half of the page. There, 2.5.3 was assigned to $\frac{50}{1}$.

The question that followed 2.5.3 was QUESTION 2-6. It was properly placed in $\frac{50}{2}$ on the PAGINATION MATRIX.

6. EXCERPTS FOR ILLUSTRATION:

6.1 PAGINATION MATRIX

	0	1	2
5	2.5.3Q	2.4.4* 2-5	
	2-6.0	2.9.2	
6	2.8.4 2-9	2.5.4	

6.2 ANSWER MATRIX

	A	B	C	D	
4	4.4* 51/1	4.1 28/2	4.2 39/2	4.3 40/1	
5	5.1 38/1	5.2 49/1	5.3Q 50/1	5.4 61/1	

6.3 QUESTION SHEET

VOL 13 SEG 2:
QUEST. 5:---------- 51/1

QUEST. 6:---------- 50/2

6.4 REM PAGE

2.4.4
Your answer is correct. Proceed to Question 5 which follows. 51/1

2.5.4
Wrong answer..... 61/1
Return to page 51 and choose another answer 1

2.5.3Q
....(complete explanation)..... 50/1
Proceed to question 6 below

7. PREPARATION FOR TYPING:

7.1 Separation of sheets
- 7.1.1 Separate the questions
- 7.1.2 Separate the REMS

7.2 Sort according to page number

7.3 Collate according to page number (including both halves) and staple together.

7.4 The typist then can prepare a complete page.

The SCHEMATIC DIAGRAM on the opposite page shows the FUNCTIONS of

PROGRAM CONTROL:	or the equivalent:
PUNCH CARD	LATENT IMAGE (MARK SENSE)
ANSWER MATRIX	RESPONSE SHEET

in the directing of the student through the

SCRAMBLED PAGINATION of the STUDY GUIDE

Specific references are made for illustration of continuity of step sequence.

1. STUDY GUIDE:
   Student reads question 4 on page 20/1 which relates to Vol. 5, Seg. 3

2. PUNCH CARD:
   Student solves problem and picks answer choice A (DISTRACTOR). He records his choice by punching out perforations on a punch card which has been inserted in PROGRAM CONTROL. This action causes a bulb to light up on light panel. The light shows through the prepared ANSWER MATRIX revealing the page in the STUDY GUIDE to which he should turn. (51/1)

3. REM PAGE:
   He receives remedial instruction on the nature of his error which is referenced to the concept catalog number and he is directed to return to the question (page 20/1)

4. REM-LOOP:
   This process is repeated. If he chooses:
   DISTRACTOR B (where he is referred to page 28/2) or
   DISTRACTOR C (where he is referred to page 39/2)

5. QED PAGE:
   When he chooses the correct answer (in this example, D) he is referred to page 40/1 where he receives further reinforcement in reviewing a complete demonstration of the solution of the problem.

6. NEXT QUESTION:
   He is then directed to the bottom of the same page 40/2 , for question 5 and the process is repeated. Note that he doesn't see the next question until he has located the previous correct answer.

7. The PUNCH CARD (or LATENT IMAGE MARK SENSE RESPONSE SHEET) is forwarded to the computer for input and analysis.

8. The ANSWER MATRIX (or LATENT IMAGE SHEET) is replaced for each SEGMENT.

MULTIPLE BRANCH STRATEGY: